FOOD TECHNOLOGY

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May, 1957 Volume 11, Number 5

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Q. What have Canco scientists discovered about citrus "off-flavor"?

A. Some frozen citrus products develop a mild "tallowy mouth-feel" and "castor-oil odor" soon after packing. These characteristics are not present in the fresh fruit and tend to disappear with prolonged storage. As reported by Dr. J. S. Blair in the February, 1957, issue of Food Technology magazine, Canco research indicates that this so-called "COF" effect is related to the biochemical production of fats from sugars in the frozen products.

Q. How is the calendar related to occurrence of citrus "off-flavor"?

A. Technologists of the citrus industry discovered that this temporary off-flavor is more apt to develop in frozen products prepared from early-ripening varieties of fruit, or from fruit which, while fully ripe by the accepted standards, is physiologically immature. This observation prompted tests in the Canco laboratories which showed that "COF" is caused by changes in the natural enzyme systems which are more active in immature than in mature fruit.

Q. How do Canco scientists measure "COF"?

A. The odor associated with "COF" is attributed to extremely small amounts of the offending substances. That the effect is perceived at all is a tribute to the extraordinary sensitiveness of the human nose to odors. Infrared spectrophotometry, which has served well in the study of other citrus flavor problems, could not be used in this case as the infrared equipment was not sensitive enough to measure "COF". It was necessary to use sensitive color tests which were measured by spectrophotometry in the region of visible light.

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IFT ACTIONS AND REACTIONS...

PUBLIC HEALTH SERVICE RESEARCH GRANTS IN THE FIELD OF ENVIRONMENTAL HEALTH INCLUDING FOOD TECHNOLOGY

Irving Gerring *

The Division of Research Grants of the National Institutes of Health was established late in 1945, and is responsible for the administration of all research grants and fellowships programs. Public Law 410 of the Public Health Service Act authorizes this program. Section 301 of this law states in part: "The Surgeon General shall encourage, cooperate with, and render assistance to scientific institutions and scientists in the conduct of research, investigations, experiments and studies relating to the causes, diagnosis, treatment, control, and prevention of the physical and mental diseases and impairments of man, including studies of water purification, sewage treatment, and the pollution of lakes and streams."

This same law requires that all research grants approved by the Surgeon General receive prior recommendation by the national advisory councils established for this purpose, councils which are comprised for the most part of non-Federal authorities in various phases of interest. To assist the advisory councils on highly technical matters, study sections of experts in some 20 special fields of interest were appointed. These study sections, including one in environmental health, have two major responsibilities: (1) to review applications for research grants and provide technical advice on action to be taken, and (2) to survey the total research being conducted in their particular fields in order to stimulate additional work in neglected areas. These councils and study sections have, therefore, responsibility for a major portion of the guidance and administration of the program.

The Sanitary Engineering and Occupational Health Study Section, at first called the Sanitation Study Section and later the Environmental Health Study Section, was organized in the fall of 1946 and consisted of 15 individuals mostly from non-Federal institutions who were recognized as authorities in the sanitary sciences such as milk and food sanitation, insect and rodent control, water supply, stream sanitation, sewage and industrial wastes, industrial hygiene, and atmospheric pollution. Each year about 25 percent of the membership of the Section is replaced to assure flexibility in the development of research programs.

Individuals find it advantageous to affiliate with universities or institutions because this affiliation facilitates the administration of the grant, provides the research worker with better facilities, and promotes collaboration with colleagues in related fields.

* Executive Secretary, Sanitary Engineering and Occupational Health Study Section, Division of Research Grants, National Institutes of Health, Public Health Service, Department of Health, Education, and Welfare, Bethesda 14, Maryland.

Research projects related to environmental health are eligible for support so long as they bear directly or indirectly upon problems of health or disease. Projects exclusively or predominantly of local importance and those which merely demonstrate the application of accepted scientific techniques are usually not recommended for support.

The aim of the Public Health Service is to promote the highest quality of endeavors in both fundamental and applied research, without restrictive regulations. Complete scientific freedom is accorded the investigator. Although applications for grants are evaluated primarily on the basis of scientific merit of the proposal, the scientist is free to modify his research design as the study progresses, and to publish his results as he sees fit.

It is important to note that the very title "Research Grant" connotes a distinction between projects that are only demonstration or control measures and those that are research. It is realized that many projects in environmental health are a combination of demonstration, control, and research activities. In such cases, the Study Section must make the determination, sometimes difficult, as to where the true emphasis lies.

Criteria of Selection

Among the criteria to which an application is subjected are the following:

1. Is the investigator competent to do the work proposed?
2. Is the problem significant to medical or closely allied research?
3. Will the applicant have the necessary facilities to do the work?
4. Does the project director have so many other responsibilities that he cannot give the necessary time to the research?
5. Is the requested budget reasonable in relation to the work proposed?
6. Is the proposal clearly defined and planned, with comprehension of previous work related to the problem?
7. Is necessary collaboration from fellow scientists or other agencies definitely assured?

In the field of Environmental Health in the Public Health Service research grants program during the ten-year period 1947-1956, 18 projects have been supported in food and milk technology through recommendation of the Study Section and National Advisory Council concerned. These 18 projects have been awarded funds on an annual grant basis and are shown as 42 grants for the ten-year period in the amount of $309,424 (see Figure 1 and Table 1). This would indicate that an average of only two projects a year has been acti-

(Continued on page 6)

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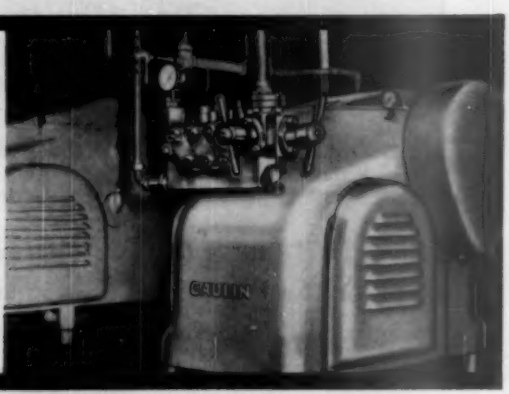

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Office of the Editor

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Business Manager

CHARLES S. LAWRENCE

176 West Adams Street, Chicago 3, Illinois

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(Continued from page 2

vated with annual average support of $31,000. Of the total of $3,300,627 for support of all other projects in environmental health only 10 percent has been awarded to food and milk research. Furthermore, of the total of $199 million appropriated in support of all medical,

Research Grants IN SANITARY ENGINEERING AND OCCUPATIONAL HEALTH

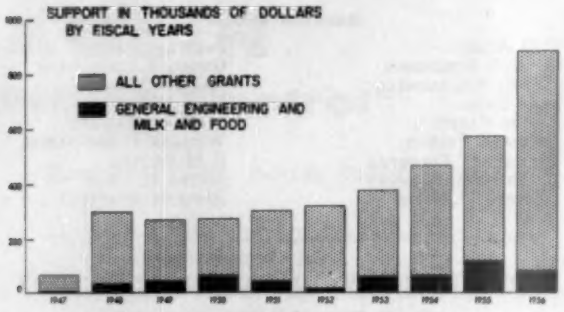

Figure 1

public health and allied research in the Public Health Service program of research grants (1947-1956) it can readily be seen that food technology research has been a very small fraction of the Public Health Service research grants activity.

More Food Research Projects Urged

In proportion to its importance, research in food technology from the viewpoint of developing fundamental knowledge has made little advance, at least in this program. Leaders in this field have pointed out that too little has been accomplished in basic studies leading to new knowledge or improved methods for prevention of diseases caused by foods.

TABLE 1
General engineering and milk and food research grants and all other SEOH research grants (See Figure 7)

Fiscal year	Gen. engr. grants		Milk and food grants		All other grants	
	Number	Amount	Number	Amount	Number	Amount
1947	1	$ 3,350	0	0	5	$ 62,934
1948	3	27,552	2	$ 8,376	31	261,661
1949	2	31,891	4	11,815	27	225,636
1950	2	33,844	5	30,982	31	206,575
1951	0	0	6	42,629	35	260,750
1952	0	0	1	16,295	40	303,698
1953	1	19,500	5	39,454	40	315,946
1954	2	15,500	7	48,191	37	403,153
1955	4	48,719	8	70,052	30	452,365
1956	4	31,314	4	41,630	65	807,909
Totals	19	$211,670	42	$309,424	361	$3,300,627

Public Health Service consultants who have been and are members of the Study Section and National Advisory Councils concerned have advised that additional research should be instituted in the field of food technology. It is their consensus that problems in general needing further research should deal with the

(Continued on page 8)

The Quicks and the vitamins

This is the Jane Armbruster that was. She used to check vitamin A potency of fish liver oils on our old spectrograph like this back in the forties.

At that time one Wallace J. Quick chased around half the world for us looking for the fish liver oils that Jane checked. Proximity, etc. They got married. A chain of events ensued. ➡

Moreover, in 1947 we introduced man-made vitamin A to the American market. Before long there was very little need to check fish liver oil. So today, instead of "playing" a spectrograph, Jane plays music on her electronic home organ and takes care of Wally and their girls.

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(Continued form page 6)

safety factors involved in the processing and preparation of foods such as packaging, storage, distribution, consumer handling and servicing. Among the factors to be considered are those of a microbial nature created by newly developed commercial processes in the freezing, drying, chilling, and radiation of food and milk products. In addition, research is needed on the toxicological and nutritional aspects relating to the use of insecticides, pesticides, and chemical additives in food processing. Field studies based upon epidemiologic and biostatistical approaches are important to determine the agents responsible for food borne disease.

Some projects currently in progress. To indicate the types and to give some idea of the food technology projects that have been activated as a result of support in the Public Health Service research grants program, there follows a list of some of those currently in progess.

Project no.	Title of project	Investigator	Institution
E-450(C3)	Effect of certain antibiotics on microflora and enzymes in milk and milk products	Ira A. Gould	Ohio State U.
E-792(C2)	The physiology of spores of some anaerobic food spoilage bacteria	Arnold J. Lund	U. of Minnesota
E-987(C)	Improvement in factors of environmental sanitation by ionizing radiations	Bernard E. Proctor	M. I. T.
E-1173	Studies on the thermal death time characteristics of some organisms in milk	Warren Litsky	U. of Mass.
E-1430(C2)	Incidence and kinds of micro-organisms occurring in or on poultry	John C. Ayres	Iowa State Coll.
E-1539	Adsorption of antibiotics in milk	Ira A. Gould	Ohio State U.
RG-1947(C6)	The effect of high temperature on the inactivation of enzymes, on the destruction of micro-organisms, and on some physicochemical properties of milk and cream	E. O. Herreid P. H. Tracy	U. of Illinois
RG-2384(C5)	The effects of residues of newer insecticides on health	Loren E. Harris D. A. Greenwood	Utah State Agri. Coll.
RG-4060(C)	The rate of inactivation of micro-organisms by heat in milk and milk products	S. A. Lear	Rutgers U.
RG-4407	The public health significance of antibiotic residues in the edible portions of horticultural crops	R. N. Goodman H. S. Goldberg	U. of Missouri
RG-4743	Contamination of cereal grains	J. A. Callenbach	No. Dak. Agric. Exp. Station

A dearth of applications in food technology. It is obvious that there has been a dearth of applications submitted for Public Health Service research grants in food technology.

There are substantial ways to develop, stimulate, and encourage research potential in this field from the standpoint of personnel and facilities. One way might be through the combined efforts of the research committees of one or two of the large professional food technology or research associations by conducting a survey among consulting food processing engineers, industrial food technologists, food research and educational personnel, and others, to determine selection of problems for investigation and to distribute the findings through published reports. The next step might be to visit universities and other institutions potentially capable of conducting projects in order to discuss the problems and to stimulate cooperative interest at such institutions, especially in their graduate departments of chemistry, physics, biology, bacteriology, physiology, toxicology, biostatistics, and sanitary engineering because it takes the combined knowledge of all of these disciplines to promote and accomplish some of the best basic studies in food technology. Another way might be through the establishment of an intersociety committee of the large professional food technology associations to meet at frequent intervals with industrial groups in the food preparation, processing, and distribution fields not only for the purpose of discussing mutual problems but primarily for planning strategy for accomplishing the necessary research work to solve these problems. The full cooperation and understanding of industrial management, universities, and other research institutions and technical societies are most essential to cope with the ever increasing milk and food processing developments.

Through the mechanism of the Public Health Service research grant operation, funds are available for good proposals, but it is a certainty that to accomplish the tasks in this vast and important field much aid in exposing the needs and organizing methods and approaches to getting the work done will have to come in large measure from the interest shown by professional organizations. Obviously, funds alone do not develop good research. There is no doubt a need for the

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(Continued from page 8)

training of research scientists in food technology and related sciences at the graduate level with the ground work to be laid for preparation of such scientists at the undergraduate level. This can be done through careful planning with the aid of active groups concerned whether the stimulus be from university professors or research committees of professional societies. In this connection there is within the framework of the Research Grants Division a fellowship program which grants stipends for the training of research scientists through the master's and doctor's level in all facets of medical and related research, including food technology. There have been no students in this field who have applied for and taken advantage of this opportunity.

Personnel properly oriented and trained for research will serve as one of the most significant long-term stepping stones in satisfying the many unanswered questions that confront State and local public health officials.

The Public Health Service through its Division of Research Grants is prepared to cooperate in the further advancement of research which is directly of concern to professional societies and other groups and would appreciate any assistance that is given toward development, encouragement, stimulation, and increase of research activities in this field. Support in this direction might be served through meetings of members of the Public Health Service research grants staff with designated members of professional society and industrial research committees to discuss mutual interests for the purpose of taking positive action. We shall be glad to hear from those interested and try to assist in any way we can.

How to Apply

Requests for research grant support should be submitted by an institution on behalf of an investigator's proposed research, using special application forms which may be obtained by writing to the Division of Research Grants, National Institutes of Health, Bethesda 14, Maryland. Included with the application will be instructions for its preparation, an information statement pertaining to the program, and the appropriate dates for submitting the proposal. Such research proposals in almost all instances will reflect the initiative and originality of the investigator.

SOLDIER SCIENTISTS MEET WITH INDUSTRY REPRESENTATIVES AT IFT SPONSORED CAREER CLINIC IN CHICAGO

Let's call it a "career clinic" which is something slightly different in the way of bringing a man and a job together.

Under the chairmanship of Colonel C. S. Lawrence, IFT Executive Secretary, some 45 military personnel in the scientific and professional category, all from the Chicago area and all interested in technical or administrative jobs in industry, met with representatives of several Chicago firms on Saturday, March 16, in the Williford Room of the Conrad Hilton Hotel. The industries represented at this first meeting included two packing companies, a steel company, a food machinery company, two can manufacturing companies and a food manufacturing concern—all from the Chicago area. The venture was experimental and exploratory, the object being to see what the response might be in order to plan further conferences. The companies selected were picked because they furnished a good sample of Chicago area industries in which the G.I.'s had an interest—a career interest.

In introducing his companions to the industry executives and personnel officers present, the spokesman for the G. I.'s Pfc. Ellard L. Pfaelzer, explained that the soldier about to finish his stint for Uncle Sam has fewer opportunities to learn about job opportunities than he desires. Moreover, since he has had time in the Service to get his career objectives in mind, he is anxious to come into direct contact with the men who can best describe what specific jobs are available to him and what future they hold. Industry representatives briefly described the various phases of their particular operations, the nature and scope of technical and administrative jobs, and a few of the features that made employment in their companies especially attractive. Dr. Martin S. Peterson and Mr. John Hennessey from the Qm. Food and Container Institute called attention to the fact that the soldier-scientist group comprises men who are in top physical condition, technically well trained, accustomed to discipline, and eager to "get going".

After these preliminary talks, the G. I.'s and the various industry representatives sat down together at tables in the rear of the room and got down to cases. Each soldier had come provided with a copy of his training and experience record.

A buffet luncheon was served at noon and after the luncheon the across-the-table talks continued well into the afternoon. In this period the companies were able to present their specific needs and the soldiers, in turn, to indicate in detail their career interests and objectives.

Consensus of the soldier-scientists was that the clinic was highly worthwhile. Further "career clinics" will be held in accordance with the demand. Food and related manufacturing enterprises in the Chicago area who have a desire to participate in future clinics should write to Colonel C. S. Lawrence, Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.

DR. ELMER MARTIN NELSON NAMED BABCOCK-HART AWARD WINNER

That Dr. Elmer Martin Nelson, Chief, Division of Nutrition, Food and Drug Administration is "distinguished by contributions to food technology resulting in improved public health through some aspect of nutrition or more nutritious food" is abundantly in evidence. This key stipulation for winning the Babcock-Hart Award could be applied to Dr. Nelson's achievements from the days when he was carrying out graduate studies under the direction of Professors E. B. Hart and H. Steenbock at the University of Wisconsin on to and through the years he has spent in Food and Drug control work.

(Continued on page 12)

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(Continued from page 10)

Born in Clark, South Dakota in 1892, Elmer Martin Nelson attended schools in that state and went on to take his college training at the University of Wisconsin (B.S., 1918; M.S., 1919; Ph.D., 1923). It was his great good fortune to be at Wisconsin during the period in which the discoveries relating to those indispensable organic catalysts, the vitamins, were under intensive research. As a result of this work, which revolutionized our ideas regarding the indispensable constituents of the diet, the feeding of the individual and that of the nation and the world have been immensely improved. Dr. Nelson's early experiments pointed out the relationship between vitamin D and ultraviolet light and provided a basis for the Steenbock patent for the irradiation of foods.

Dr. Nelson's career in the Food and Drug Administration has been distinguished by a firm but friendly and progressive attitude that has gained the respect and confidence of the industry, his fellow scientists, and the public. Symbolic of his many other achievements is his testimony in the hearing for establishing a standard for enriched flour—a contribution that led the way to the elimination of much of the malnutrition seen in this country in the 1930's. His participation in the scientific work of other food and nutrition groups, e.g., the National Research Council and the American Medical Association, has notably benefited the health of the nation. Along with his colleagues he has assisted greatly in the development of a broad program consistently based upon the most recent advances in nutrition.

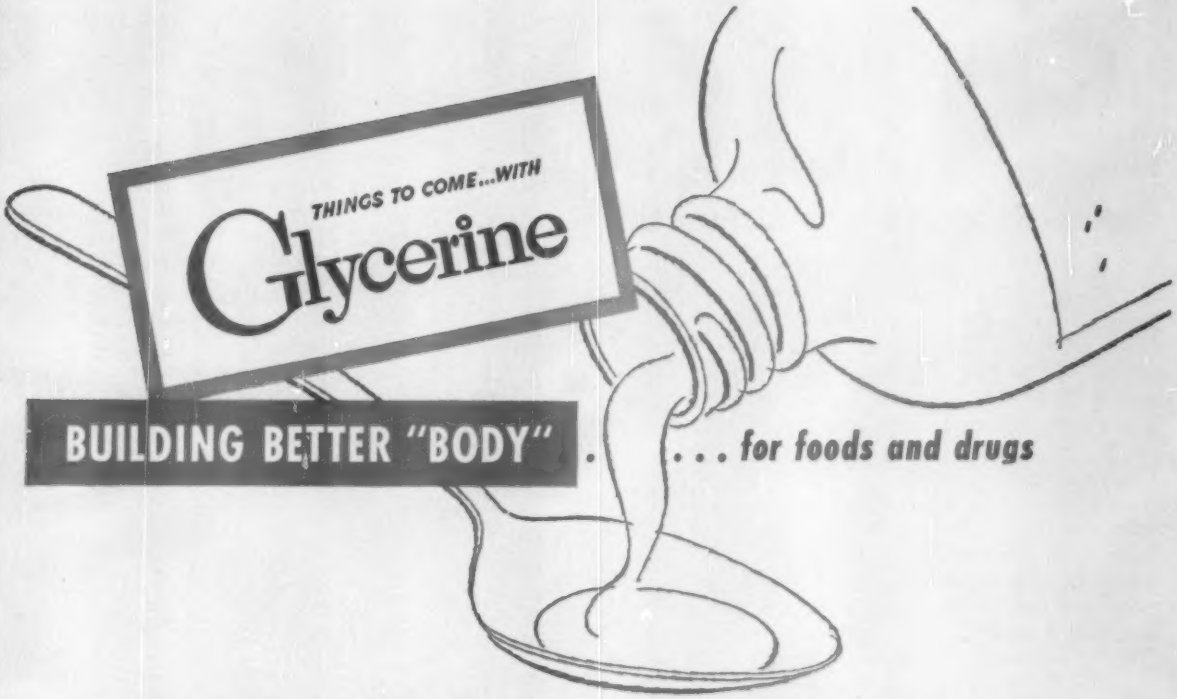
Toward a Complete Roster of Food Technology Departments

Efforts to obtain a complete roster of Food Technology departments in the colleges and universities in the U. S. A. and, ultimately, overseas have been only partially successful. The usefulness of such a list to the individual institution and department is so evident that it is surprising that the list is not yet complete. The call for data (November issue, FOOD TECHNOLOGY) elicited several replies, but far from a complete response.

In today's educational world it is more necessary than ever before to coordinate the educational objectives and philosophy of such specialized fields as food technology. To achieve coordination and effective intercommunication, a first need is a complete, accurate, up-to-date roster. The table below is as accurate and complete as it is possible to make it as of March 15, 1957. Once again, will you please send in the data on food technology training programs at your institution? Address your letter to Dr. Walter A. Maclinn, Chairman, Department of Food Technology, Rutgers University, New Brunswick, New Jersey.

COLLEGES AND UNIVERSITIES OFFERING TRAINING PROGRAMS IN FOOD TECHNOLOGY (EXCLUSIVE OF DAIRY OR OTHER SPECIALIZED PROGRAMS)

Institution	Place	Program location	Dept. or group supervising program	Leader of program
Cornell University	Ithaca, N. Y.	Dairy	Dairy	E. A. Nebeskey
Illinois Inst. of Tech.	Chicago, Illinois	Food Engineering	Food Engineering	M. E. Parker
Iowa State College	Ames, Iowa	.....	Committee	J. C. Ayres
Mass. Inst. of Tech.	Cambridge, Mass.	Food Technology	Food Technology	B. E. Proctor
Miami University	Coral Gables, Fla.	Food Technology	Food Technology	J. A. Lewis
Mich. State Univ.	E. Lansing, Mich.	.....	Committee	N. P. Ralston
Ohio State Univ.	Columbus, Ohio	Inst. of Nutr. & Food Technology	Committee	J. B. Brown
Oregon State College	Corvallis, Ore.	Food Technology	Food Technology	H. W. Schultz
Purdue University	W. Lafayette, Ind.	Horticulture	Horticulture	N. W. Desrosier
Rutgers University	New Brunswick, N. J.	Food Technology	Food Technology	W. A. Maclinn
Univ. of Calif.	Davis, California	Food Technology	Food Technology	E. M. Mrak
Univ. of Georgia	Athens, Georgia	Food Technology	Food Technology	J. J. Powers
Univ. of Illinois	Urbana, Ill.	Food Technology	Food Technology	R. T. Milner
Univ. of Maryland	College Park, Md.	Horticulture	Horticulture	Amihud Kramer
Univ. of Massachusetts	Amherst, Mass.	Food Technology	Food Technology	C. R. Fellers
Univ. of Missouri	Columbia, Mo.	.....	Committee	D. E. Brady
Univ. of N. Carolina	Durham, N. C.	Horticulture	Horticulture	I. D. Jones
Univ. of Wisconsin	Madison, Wis.	Dairy & Food Ind.	Dairy & Food Ind.	K. G. Weckel
Virginia Poly. Inst.	Blacksburg, Va.	Horticulture	Horticulture	A. Lopez
Wash. State Univ.	Pullman, Wash.	Horticulture	Committee	Mrs. M. M. Hard



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Glycerine has been known for years to be compatible with conventional water soluble gums and gelling agents such as Gum Arabic and Karaya. New studies show that Glycerine is also compatible with a majority of the new synthetic gums. In most cases, Glycerine supplements the bodying action of these gums, and the resultant formulations are relatively unaffected by freezing and thawing.

Other fields, too, will benefit from this compatibility of Glycerine. Nontoxic lubricants are now possible. Important improvements in printing inks, grinding and polishing pastes, gasket seals—all making use of Glycerine's unique balance of properties—are promised.

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FEATURING THIS MONTH . . .

New Packaging Methods Developed at Canco Research Laboratories

R. F. Ellis
American Can Company, Research and Technical Department

AMERICAN CAN COMPANY'S 50-year scientific program took on a new scope and a new look in 1955 when Canco opened its multi-million dollar research and development laboratories at Barrington, Illinois. As the world's largest laboratories devoted to packaging research, this Research Center has a responsible role in shaping the future of the can manufacturing and canning industries.

Goals of the Barrington Research Center are to develop new types of containers and container uses, new methods of container manufacture, new or improved packaging techniques. The research program has become even more diversified during the past year now that Canco subsidiaries are manufacturing plastic tubes, composite plastic containers and parts, and impact extruded aluminum tubes of various types. Expansion into the international market also has broadened the scope.

Laboratory developments are transmitted to Canco's 57 manufacturing plants and 31 auxiliary plants in the United States, Canada, Hawaii, Puerto Rico, Mexico, and South America. Ultimately, the research benefits are felt in almost every American home, for more than 400 billion containers of all types are used in this country each year. These packages carry nearly 1500 different types of food, beverage, and chemical specialty products.

Planned obsolescence. As with most progressive manufacturing companies today, Canco's manufacturing research is designed for planned obsolescence. Its scientific sights are trained on new container materials and radically new high speed techniques of container fabrication.

Along these lines, significant progress has been made in Canco's extensive "Operation Survival" program. The objective is to manufacture metal cans from materials other than tin plate. Tinless cans have already been developed for pet foods and for a number of chemical specialty products, such as motor oil, insecticides, glycol antifreezes, varnishes, and waxes. Technological development of tinless cans for a number of other non-food products is at the point where such containers could now be used if needed.

Incentive for the "Operation Survival" program is mainly one of materials supply. More than half the world's tin deposits lie in a belt around the equator, mainly in countries vulnerable to Communist expansion. The national stockpiling program provides short-term insurance against an interrupted supply of tin, but tin-free containers would soon be required if foreign tin supplies were cut off.

Most tin-free metal cans must be manufactured from steel or steel plate bearing thin metallic coatings since no other metal is now produced in sufficient quantities. Untinned steel (CMQ) is the most promising material today. Through use of new process-resistant inside enamels, protective outside coatings, and low cost chemical treatments, it may be possible to produce CMQ plate cans which will have many processed food container applications.

Cathodic etcher for etching metal surfaces to determine their grain structure.

Other types of container materials also are being studied. The most promising of these, aluminum coated steel, is now being produced in pilot line quantities. This plate has the inherent strength of tin plate, an attractive appearance, and can be used plain (after chemical treatment) or coated. Drawn aluminum cans also have been made experimentally.

Since most alternate container materials cannot be soldered readily new methods of side seam construction also are being developed. Recent production trials of welded cans on prototype equipment show that welding will play an important role in the can-making future. Welded side seams not only eliminate use of tin and lead solder, but also provide much stronger cans than the conventional soldered type. They are so strong that under test conditions the steel walls of the cans break before the welded seams separate.

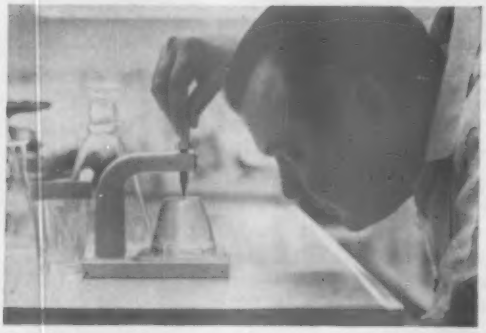
Formulation of new types of organic coatings is high priority work. Many of the present enamel coatings perform poorly on chemically treated steel or alternate container materials. New coatings are being formulated at Barrington for many of these applications.

(Continued on page 16)

One look at the huge, sprawling buildings at one of the Exchange Products plants and you know that big things are happening inside. For here *citrus* is king. Trucks pour in with fresh fruit from groves all over California and Arizona. Conveyer belts hum along in every direction. And Exchange products are shipped to nearly every part of the world.

Why 'Exchange' products serve you better

Utmost cleanliness is the watchword at Exchange Products plants. Everything has that "just washed-down" look. Every four hours, extraction equipment is completely cleaned. Every third day, the entire plant closes down for a thorough washing.



Exchange quality is assured by constant checking in extensive testing laboratories. In fact, rigid quality controls have been set up *throughout* the plant to make sure that every product measures up to Exchange quality. Sunkist produces more than 400 different citrus products.

The world's largest citrus research department is maintained by the Sunkist Growers to develop new growing methods, to improve manufacturing processes, and to perfect better products. Today, with a backlog of more than 60 years experience, Sunkist has accounted for 118 separate U.S. patents.

Just three of many Exchange products are *Exchange Preserver's Pectin*—guarantees a more uniform finished product; *Exchange Low Methoxyl Pectin*—jells *without* sugar, tasteless, controls "weeping" in pies; *Exchange Lemon Juice*—brings out natural flavor of *any* food. Superior acidulant, excellent anti-oxidant.

Sunkist Growers

PRODUCTS DEPARTMENT • ONTARIO, CALIFORNIA

Distributors for

Exchange Lemon Products Co., Corona, Calif. • Exchange Orange Products Co., Ontario, Calif.

(Continued from page 14)

Two new, radically different coatings. At least two radically different types of organic coatings may find commercial application in food containers in the foreseeable future. One of these now being developed contains two or more reactive components plus catalysts;

Correlating microscopic structure of steels with corrosion resistance of tin plate.

the chemical reaction between these components which produces the film is induced by the bake. The second type might be described as a solution type of coating capable of being applied at about ten times the thickness of conventional enamel films used today. Both types could be applied at high speeds.

Laboratory facilities include reactors and cooking kettles for preparation of experimental quantities of new coatings. Laboratory model roller coaters, dip-coaters, and spray coaters are used for application of the coatings to the plate.

Radical changes in present compound lining procedures obviously will be required for these new container materials. Both synthetic rubbers and thermoplastic elastomeric resins are being studied for possible new uses. Resin type side seam cements have already been developed for commercial use on cans for frozen citrus concentrates, motor oil, detergents, and many chemical specialty products. High polymer based materials also are being synthesized for use as "plastic solders" and container linings.

Attempts also are underway to improve the performance of tin plate and by so doing make possible the use of lighter coating weights. Factors affecting the corrosivity of foods and the corrosion resistance of tin plate are being studied under several different research projects. In addition, various types of rust inhibitors and methods of application are being tried. Chemical treatments for steel are evaluated for their versatility with food and non-food products.

Similar research is in progress to develop new types of fibre and plastic containers. Paraffins and plastics are evaluated for use as moisture-resistant films for fibreboards. These materials also are modified with an eye toward the strength and rigidity they impart to completed packages. Plastic laminating and extruding equipment and many different types of standard paper testing instruments have been installed at Barrington for use in this work.

Components of the forward look. Another area of activity revolves around improving canned foods and developing new canned products. A well-equipped canning kitchen is available at Barrington for these food technology studies. Various types of mixers, fillers, and retorts are used to duplicate on a laboratory scale the food preparation steps and canning operations of commercial canneries. A number of interesting new canned food specialty products are now being developed under this program. One of these, red cherry sauce, appears to have excellent market potential as a topping for meats, salads, and desserts.

HT-ST. Studies have shown that the quality of many canned food products can be improved through use of high temperature-short time processes. Further work is being done with these techniques.

Radiation. Food processing by atomic radiation is also being investigated. Gamma rays are extremely penetrating but require massive shielding and intricate safety devices to protect the operator. Ionizing radiation from other sources may be more promising. Radiation treatment of foods most likely would be used first in combination with other methods of preservation, complementing rather than replacing the more conventional techniques.

Antibiotics. Incubation studies on samples from these processing tests are made in the bacteriological laboratory. In this area, work has been done with antibiotics as possible spoilage inhibitors for canned foods. An animal colony is maintained for toxicological studies. Work also is done to determine the nutritional values of various canned foods and to study the factors affecting vitamin stability and retention.

Bio-assay.

Well-equipped for long-range studies. Long range exploratory studies into new applications of chemistry and physics are done by other scientists, using such highly specialized instruments as the emission spectrograph, beta gauge, and spectrophotometers. Work in

(Continued on page 18)

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(Continued from page 16)

this area often covers the gamut of packaging research. For example, an electron microscope which has a 30,000 magnification is employed to study the surface structures of metal surfaces. Another instrument, the infrared spectrophotometer, has been extremely helpful in identifying the factors affecting flavor in canned orange juice. The laboratories are equipped with more than 500 pieces of scientific equipment for physical measurement and analysis.

Organization plan achieves unity and diversity. To expedite research, work at the Research Center is organized into four distinct areas: Container Utilization, Metal Containers, Paper and Plastic Containers, and Exploratory Research. The staff is headed by a Director of Research and an Associate Director for each of the four operating sections. Project activity is coordinated by section supervisors and their group leaders.

With project team plan, many scientific skills can be applied to a packaging problem.

Although responsibility for each project is assigned to a specific section, the research work is done on a team basis. Teams of specialists are assigned to each project, often from several different laboratory groups and with varying training backgrounds. The scientific staff of 140 represents such diverse fields as chemical engineering, metallurgy, bacteriology, high polymer chemistry, food technology, electrical engineering, plastics technology, mechanical engineering, paper technology, analytical chemistry, physical chemistry, organic chemistry, and biochemistry.

The company's Development Division, a separate unit, is also located at the Barrington laboratory. This division is responsible for testing the practicality of manufacturing and packaging innovations under actual manufacturing conditions. It maintains a machine shop and several production lines on which small lots of containers can be produced under conditions that simulate those in Canco's manufacturing plants.

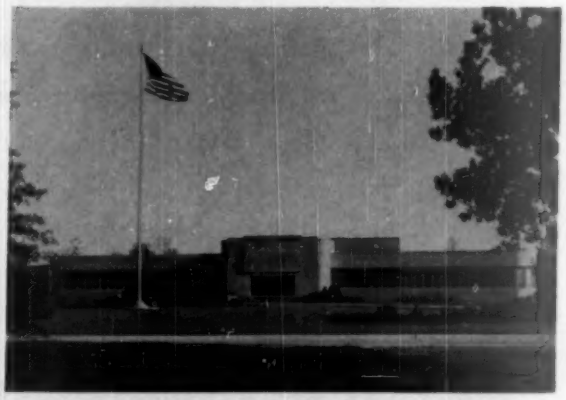
Top management guidance on all Canco research and development work is provided through a Project Control Committee. This group is made up of two representatives from the Research and Technical Department, and one representative each from the Manufacturing, Machinery, New Products, Purchasing, Sales, and Comptroller's Departments. At quarterly meetings the Committee determines what areas of research should be covered and the amount of effort that should be extended to each. With laboratory counsel, the Project Control Committee has the final decision as to whether or not a project should be started or abandoned. Their decisions are influenced by the expected profit or competitive advantages to be gained through the research.

A look at the "campus" and its resources. The new Canco Research Center is located on a landscaped 40-acre tract about 45 miles northwest of Chicago. Its buildings are arranged in a series of sprawling, inverted T's. This plan provides outside lighting for most laboratories and testing areas. It also facilitates expansion of any one wing without disrupting other areas of the laboratory. All wings are interconnected by a central corridor.

A sub-level area contains 40,000 cubic feet of controlled temperature storage space. In these rooms test packs may be kept at arctic to tropic temperatures ranging from —20° to 135° F. Each room is provided with separate heating and/or cooling units with individual thermostats. Visible signals record any deviation from the prescribed operating range.

A partial second story houses the cafeteria-conference room, which has a built-in public address system. Sliding wall panels make it possible to divide the room into several separate conference areas.

To aid scientific study, the Center has its own library with about 2,000 bound volumes plus over 100 different periodicals. Its facilities are augmented by libraries at other Canco laboratories. The librarian checks all incoming periodicals for pertinent information. Her abstracts and notes of specific articles are distributed to interested members of the staff. An extensive file of patents also is maintained.



American Can Company Research Center at Barrington, Ill.

The Barrington Research Center is the newest unit of Canco's expanding scientific organization. Its Research and Technical Department also operates technical service laboratories at Maywood, Ill.; Newark, N. J.; San Francisco, Calif.; Hamilton, Ontario; Los Angeles, Calif.; Tampa, Fla.; Seattle, Wash.; Vancouver, British Columbia; and Montreal, Quebec; and

(Continued on page 20)

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(Continued from page 18)

has agronomists in each of the Company's four geographical divisions. Over-all management of this department is the responsibility of Vice President Roger H. Lueck of the company's General Office in New York.

Since their origin in 1906, the Canco laboratories have pioneered much of the research on can manufacturing and canning technology. Many of the developments which are now commonplace in the industry originated in the earlier laboratories. Now with the expanded and greatly improved laboratories at Barrington, research can be continued with even greater effectiveness, providing new methods and new types of containers for the packaging industry.

IFT REGIONAL SECTIONS . . .

SPEECHES, SPECIAL EVENTS, NEWS NOTES

Modified Carbohydrate Gums[a]

G. K. Greminger, Jr.
Cellulose and Plastics Laboratory,
The Dow Chemical Company

WATER-SOLUBLE GUMS have been either natural or added ingredients of man's diet from earliest times. Gums serve many useful functions in foods, such as emulsification, stabilization, and thickening. They also add acceptable appearance and consistency. Natural gums are used today in many products—ice cream, beer, icings, cheese, salad dressings, and confections. However, the natural gums have limitations, such as variation in properties in response to variable growing conditions, lack of good stability to micro-organism attack, and acidic pH. Many of these gums also come from areas vulnerable to Communist unrest.

G. K. Greminger, Jr.

Synthesis of modified carbohydrate gums from one of our abundant renewable resources, cellulose, has greatly extended the use of water-soluble gums, provided uniformity in properties, and has permitted tailoring of properties to fit specific uses. This paper will cover only one group of these materials, the water-soluble methyl ethers of cellulose.[b]

Cellulose, in the form of wood pulp or cotton linters, plus brine, natural gas, and oil, in the form of caustic soda, methyl chloride, and propylene oxide provide the raw materials for the methylcelluloses. Cellulose is basically a carbohydrate polymer containing the anhydroglucose ring as the repetitive building unit. There are 3 hydroxyl groups on every glucose ring which are available for reaction. By controlling the amount and type of substitution at these points, it is possible to produce a range of methylcelluloses of widely varying properties. As commercial development of methylcellulose continued, a need for special derivatives arose, so today a family of Methocels is available, each tailored for specific needs.[c]

Properties of the methylcellulose gums. Water-soluble methylcellulose possesses a property unique among the edible water-soluble gums presently available for food uses. When an aqueous solution of methylcellulose is heated to a critical temperature, governed by viscosity type and the concentration, a transformation from a sol to a gel structure occurs. At this point, if sufficient methylcellulose is present, a solid structure or gel is formed; otherwise a suspension of gel particles results. This thermal gelation is reversible and the cycle may be repeated indefinitely without change in the chemical structure of the methylcellulose. This fundamental property is the key to many of the functional uses of the methylcelluloses in the food industries.

Methylcelluloses are edible film formers — useful properties where food coatings or strengthening of dough structures are desired. These films also have low oxygen transfer values and should retard oxidation.

Methylcelluloses are also excellent thickeners, stabilizers, and emulsifiers. There are many places where an edible surface active material can improve the quality of a food item. A wide range of viscosity types is available, permitting many combinations of thickening and surface activity.

All methylcelluloses discussed in this paper are nonionic and contain no sodium salt as a major part of their structure. This is important in formulating low sodium dietary items.

Most important requisite of a food additive, in addition to utility, is safety. A very extensive laboratory, clinical, and industrial experience has established the safety of the use of the Methocels in products for oral ingestion.

In selecting the best methylcellulose for a particular

[a] Presented before the Great Lakes Section of IFT, Midland, Michigan, October 19, 1956.

[b] Marketed as Methocels® the registered trade-mark of The Dow Chemical Company.

[c] Members of the Methocel family of interest to food processors are Methocel USP; Methocel 65 HG, a high thermal gel methylcellulose; Methocel 60 HG, a methylcellulose which combines water solubility with thermoplastic properties; and Methocel 90 HG, which has a thermal gel point above pasteurization temperatures.

(Continued on page 22)

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KRUSTO Batter and Breading Mixes for meat, fish, and fowl items. Rich flavored, made of "crumb" loaf—fat-free for higher pick-up.

(Continued from page 20)

use, Methocel USP should be used where maximum thermal gelling is desired at the lowest possible temperature. Methocel 65 HG should be used where intermediate gelling temperatures are required. Methocel 90 HG, a development item at present, permits processing at pasteurizing temperatures without thermal gelation of the methylcellulose. Finally, Methocel 60 HG is used where a combination of heat sealing, thermoplastic, and water-soluble properties are desired—for example, water-soluble envelopes for food products.

Thus by controlling reaction conditions, it is possible to tailor-make a series of methylcelluloses with varying properties to fit a wide range of uses in the food industries. A viscosity range of 15 to 7000 cps. is available. Surface tension can be varied from 43 to 52 dynes/cm. Compatibility with and solubility in organic solvents ranges from low to high. Thermal gel points can be varied from 45° C. to over 90° C.

The Methocel family provides the food processor with a wide variety of property combinations which allows him to select the material best suited for his particular problem.

Methylcellulose — the dietitian's alternative. Methocels perform many functions in a wide variety of food items ranging from a non-metabolized bulking agent in diet crackers to corn bread and dipping batters for fried fish products. Let us look at some specific examples.

Foods for Special Diets. The person faced with the need to stay on a special diet also faces the problem of obtaining a variety of palatable foodstuffs. This is one of the biggest barriers to keeping allergy patients on restricted diets. Much of the early food research at Dow was focused on the use of the methylcelluloses in dietetic items.

For the Diabetic. Our millions of diabetics are constantly faced with the problem of regulating the sugar content of their diet. Sugar-free items are often not very palatable when lacking the viscosity properties found in sugar-sweetened foods. The methylcelluloses in combination with synthetic sweeteners have been used to formulate maple syrup type products for diabetics. Research is currently in progress on the formulation of better dietetic jellies. Since the methylcelluloses are not metabolized, their ingestion has no effect upon the sugar metabolism of the diabetic.

For the Obese. Controlling the obesity of our overfed, underexercised citizenry is becoming an increasingly serious medical problem but is being attacked on many fronts. Under the supervision of a physician, methylcellulose in the form of tablets or crackers has proved useful in helping a person make the transition from a high to a low calorie diet. Dr. Jonas of New York City in a recent paper has shown that where psychological factors of a mild degree are involved in the person's desire to overeat, methylcellulose proved very helpful in satisfying this desire, thereby reducing the patient's calorie intake.

In addition to its use as a bulking agent, methylcellulose can also extend the range of acceptable low calorie food items. Good salad dressings of greatly reduced oil content can be prepared. The non-ionic methylcelluloses are used with the calcium salt of cyclamate sweeteners in low calorie soft drinks. Additional items include gravy and sauce mixes.

For the Allergic. Persons allergic to eggs are in a particularly bad way since eggs perform so many functions in emulsification, whipping and structure forming. The methylcelluloses have properties which are similar to many of the properties of egg protein. They, too, are emulsifiers, possess whipping properties, and are excellent film formers; they have been used successfully in egg-free baked goods.

Baked goods made from flours other than wheat often lack desirable texture and cutting properties since these dietetic flours lack the gluten of wheat. The use of the methylcelluloses can compensate for this lack and methylcellulose is currently being used in spoon bread and hush puppy mixes to get better volume and texture. This additive also reduces crumbling.

Miscellaneous uses. Dehydrated food products are a growing field. The U. S. Department of Agriculture has patented the use of methylcellulose for improving the resuspension properties of dehydrated fruit and vegetable juices. This type of application should also be of interest to processors of other dehydrated products such as eggs.

Since the thermal gel point of methylcellulose is reversible, in contrast to that of many proteins which gel irreversibly, methyl-cellulose aids in improving the reconstitution properties of dehydrated products.

Methylcelluloses should also be of interest wherever a water-soluble, edible film is required. An application of this type is the use of methylcellulose in a coating for a meat bar developed by the Quartermaster Food and Container Institute for the Armed Forces. These films have low permeability to oxygen, and low moisture pickup even at high humidities. Methylcellulose has also proved useful in coatings for hams and sausage casings. It was successfully used as a non-stick coating on candy-coated chewing gum shipped to tropical areas. Such coatings combined with antioxidants and possibly with antimycotics should also be of interest to processors of fish.

One of the new members of the Methocel family, Methocel 60 HG, also has interesting potential applications in the food field. It possesses the best surfactant properties of any of the Methocels and can be used to stabilize flavor and essential oil emulsions.

Since this product can be handled as a thermoplastic, it has potential uses as a water-soluble packaging film. This sheeting can be heat or electronically sealed to form various types of tubes and envelopes.

The thermal gel point of methylcellulose has led to an interesting use as a dipping batter for fried foods. Most of us have had to struggle with greasy fried chicken. By use of a Methocel dip prior to frying, this annoyance can be eliminated with a corresponding drop in calorie content. This application of methylcellulose should also be of interest to processors of fish sticks and other frozen seafood products.

Uniform, tailor-made properties of the methylcelluloses offer a multitude of ways in which food products can be improved or designed for special uses. Non-

(Continued on page 24)

It's a measure of a man's ingenuity that he has developed an ingredient that can do wonders for the looks, the taste, the keeping and lasting qualities of all kinds of food products—**FRODEX** corn syrup solids. Take ice cream, for example: in all types, **FRODEX** enhances flavor and texture, builds heat shock tolerance and total food solids content and retards melt-down, among other things. Cakes baked with **FRODEX** have a better quality because it produces a finer grain, smoother texture and better bloom; pie crusts have better color, flake and taste. They bake faster and have longer shelf life. In frozen fruit, **FRODEX** preserves color and natural fruit texture; it is an excellent moisture conditioner in meat products, where it also reduces shrinkage and watering-off, is a superb binding agent. In catsup it retains the natural color and retards oxidation in the neck of the bottle. **FRODEX** offers distinct advantages in dry food mixes because of its unique characteristics. What more could the alert food products manufacturer ask for? (Except for additional information and the assistance of our Technical Service.) **FRODEX** is available in both powdered and granular form. **AMERICAN MAIZE-PRODUCTS COMPANY** • 250 PARK AVENUE, NEW YORK 17, N. Y.

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(Continued from page 22)

ionic, non-metabolizable, bland, demulcent, surface active, non-allergenic film forming, and bulking properties make the methylcelluloses a very versatile tool for the formulator and the research worker.

Methylcelluloses have demonstrated utility in such widely varying products as prepared food mixes, root beer, diabetic specialties, diet aids, bulking preparations, low calorie products, and edible non-tacky coatings.

That the members of the methylcellulose family are performing a wide variety of services to the economy of our daily life is evident. As their uses expand in the food industry, they will help make better food products. At the same time, in another benefit to our economy, they will create new markets for cotton, one of our basic farm products.

PHILADELPHIA . . . .

Have your ideas become the other fellow's invention? This question was posed to those attending the Section meeting on April 2, 1957, at the Drexel Institute of Technology. Speakers were: Joseph Gray Jackson, Esq., Patent Attorney; Hyde W. Ballard, Esq., Patent Attorney, James Lees & Sons, Bridgeport, Pa.; Carl A. Castellan, Esq., Patent Attorney, Rohm & Haas Co., Philadelphia; Arthur H. Swanson, Head, Patent Dept., Minneapolis Honeywell Co., Philadelphia.

The case was: Cabot vs. Himmelfarb and Sitzplatz.

Within the framework of the laws of the United States Patent Office someone becomes the first inventor. Who is it? Is it the individual who files first or is it the one who first worked on the new idea? The answers to these questions were furnished at the interesting and unique meeting on April 2. The American Patent Law Association prepared this program to help inventors and those engaged in research and development to understand the legal requirements of proof of invention. These distinguished lawyers, with testimony, exhibits and persuasive arguments actively portrayed a typical patent interference case.

NEW YORK . . . .

At the March 20th Meeting of the New York Institute of Food Technologists held at the Brass Rail Restaurant, Mr. Wilson Randle, a partner of Booz, Allen & Hamilton, management engineers, described how new product development is now recognized as "a major management function" of vital importance to business success. Based on the findings of a two-year study conducted by his firm, Mr. Randle's data-packed color slide presentation revealed the practical experiences of 400 leading companies in all major industrial fields experiences and opinions in new product management of 400 leading companies in all major industrial fields.

As a major management function, Mr. Randle pointed out, new product development can be segregated from other management functions and can be defined, organized, and controlled. Its importance to business success is seen in the contribution that product development may make to the growth of a company, and in its demonstration as "a primary influence on profit performance."

According to the Booz, Allen & Hamilton study, the analysis of new product experience and practices shows that new product development is properly a sequence of 6 distinct stages:

(1) Exploration—the search for new product ideas.
(2) Screening—the process of picking out the better ideas from the total yield of the exploration phase.
(3) Specifications—the reduction of a product idea to a concrete business proposal.
(4) Development — the conversion of a specified product idea into a physical product.
(5) Testing—planning and conducting in-use evaluations as a check on earlier steps.
(6) Commercialization—the stage of final commitment, including introduction of the product to the market and full-scale production.

Mr. Randle pointed out that there is a strong trend toward the establishment of a separate New Products Department in industrial organizations. Importance of these departments as top management functions is seen in the fact that in approximately 60% of the companies studied, the new products department is directly responsible to the chief executive office, and roughly 20% each are responsible to chiefs of marketing or research and development. Moreover, there is a tendency for more of these departments to report to the presidents and fewer to report to the lower management chiefs.

There is also a trend toward the task force concept, in which a team is built around each new product to carry it through the 6 stages of development. Successful, controlled new product development depends, however, on teamwork in which all management functions are represented on the team in every stage. The Booz, Allen & Hamilton study reveals impressive evidence that by proper application of the 6-stage approach to new product development, the success of those new products which actually reach the market is better assured. Since other studies have revealed that 80-90% of new products introduced are likely to fail within 1 to 4 years, the value of proper management of product development is vital to business success.

SOUTHERN CALIFORNIA . . . .

For your memoranda booklet:

President: Dr. E. B. Oberg, Carnation Research Center, Van Nuys

Programs: C. Gordon Beisel, Sunkist Growers, Inc., Ontario

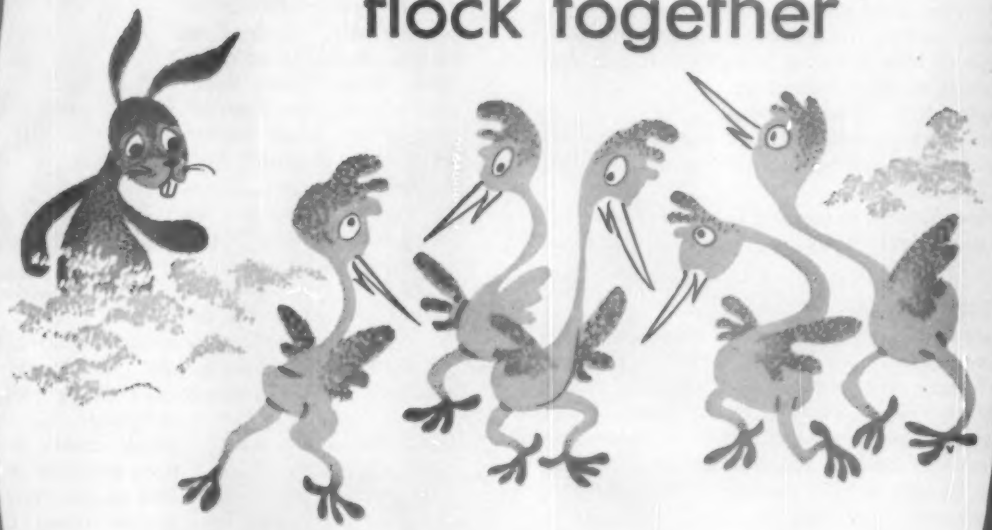
SCIFTS Programs for 1957:

SCIFTS regular meeting date is the third Wednesday of the month except during July and August when no meetings are scheduled. The organization has a con-

(Continued on page 26)

PROVERB PRATTLE

"Birds of a feather flock together"



The source of this goes back to the "Book of Wisdom" by Ben Sira written about 190 B.C. Numerous variations appear in "Promos and Cassandra" in 1578, in Shakespeare's "Henry VI" and others, including one elaborated comment in Secker's "Nonsuch Prof" of 1660: "We say that birds of a feather will flock together. To be too intimate with sinners is to intimate [illegible] are sinners too."

• Quality begets quality and if you want high quality flavors that will survive long shelf life in dry mixes without weakening or deterioration, the answer is

"Sealva Flavors"

Top quality flavors, hermetically sealed in dry powdered form for all dry packed foods.

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Alva FLAVORS

(Continued from page 24)

tract with Rodger Young Auditorium, 936 West Washington Blvd. in Los Angeles for dinners and a room. Programs for 1957 include:

April 17th—Mr. Roger Wilson, General Manager-Customer Research Department of Continental Can Company in Chicago. His topic was "New Developments in Packaging."

A May meeting is not scheduled in anticipation of a general exodus to the national meeting in Pittsburgh.

The June meeting is a special field trip on the 14th to the Joseph Schlitz Brewing Company; dinner and a talk featuring brewery technology.

September 18th—to be arranged.

October 16th—special all day session devoted to "Production and Distribution of Prepared Meals", and "Flavor Evaluation".

November-December meeting (December 4th) a special Ladies' night featuring "Carving the Holiday Roast".

March 20th Meeting

Dr. Gordon Beisel, Program Chairman of SCIFTS, was all smiles during the March 20th meeting at the Rodger Young Auditorium in Los Angeles. Without even a boost from Publicity, a record crowd of 98 had shown up to hear Nelson Carter, Vice-president of Foote-Cone-and-Belding Advertising Agency, describe "How to Launch a New Product". Mr. Carter, with over 20 years of advertising experience, emphasized the competition to be expected, sketched a sound procedure plan, and illustrated a successful launching. His recommendation in regard to action was to take it in four steps:

1) Study the product from the consumers' standpoint. Is it needed, desired, better, or sufficiently different than the available items?
2) Research early and carefully under home use; i.e. pretest.
3) Write a document that will become the marketing plan.
4) Test-market the plan, but "walk before you run".

WESTERN NEW YORK . . .

The Buffalo Subsection held its fourth and final meeting for the 1956-57 season at the Erie County Technical Institute, 1685 Elmwood Ave., Buffalo, N. Y., on March 18th. Mr. Robert J. Sherry, Manager of Industrial Relations, Continental Can Co., Syracuse, N. Y., was guest speaker and his topic was "Labor Relations — Management Negotiates with Organized Labor."

MEXICO CITY . . . .

Dr. Emil Mrak, president-elect of the Institute of Food Technologists, journeyed to Mexico City on March 8th to present a Charter to the Mexico Section No. 26 on March 9th at a special luncheon.

It was a real pleasure to receive Dr. Mrak here in Mexico. There were several members and friends to meet him at the International Airport. We are very sorry that his stay in Mexico was so short. He did promise us, however, that he would be back as soon as possible for a longer stay.

President Millares
Mexico Section No. 26

On March 9th, at two o'clock, occurred the special "charter day" luncheon at the famous Restaurante Pabellón Suizo (Swiss Pavilion) where a large turnout enjoyed the good food — which was prepared in a wonderful manner. All of the food presented was the product of Mexico. It was an auspicious occasion.

Dr. Ricardo Millares, Section President, opened the ceremonies and introduced Dr. Emil M. Mrak to the members and visitors. Dr. Mrak talked to us about the development and the growth of food technology, assisted with slides, charts, and graphs, from the time of the Civil War in the States until the present time. Dr. Mrak presented the Charter of the Mexico Section to Dr. Ricardo Millares, our able leader, who responded with a gracious speech of acceptance.

W. E. McAllister
Secretary of the Section

We in Mexico are very proud and happy to be a part of the Institute of Food Technologists and will do all within our power to uphold the principles of the organization. We stand ready at all times to assist in any way possible for the betterment of Food Technology. We are off to an excellent start and are confident that there is a real future here for a technical society devoted to the improvement of foods and beverages.

PITTSBURGH . . .

The Section held its 33rd official meeting on March 5, 1957 at the Royal York Apartments Dining Room. This meeting was the annual Ladies' night. Following a very pleasant social hour and an excellent dinner, the meeting was called to order by the chairman, Dr. C. R. Stumbo. Dr. Stumbo welcomed the lady guests and expressed the appreciation of the membership for such a fine turnout for this annual affair. The chairman

(Continued on page 28)

at long last...

an **IMITATION RASPBERRY**

with right-off-the-bush flavor!

GIVAUDAN'S NEW IMITATION RASPBERRY FLAVOR is an achievement long desired throughout the flavor-using industries.

Developed with painstaking care through many years of research, it duplicates with all of its fugitive and delicate nuances the rich flavor of the ripe raspberry as it comes fresh from the bush!

This new Givaudan development provides you with an opportunity to enhance—with true economy—the appeal of your raspberry-flavored products. Its high concentration and proved stability make it ideal for virtually every type of product in which raspberry is a popular flavor. We invite your inquiries.

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(Continued from page 26)

then requested the members to vote on the revised by-laws of the Pittsburgh Section. It was moved, seconded and unanimously approved by the members present to accept the revised by-laws.

Dr. I. J. Hutchings spoke briefly concerning the '57 Convention program. Miss Helen Wigman gave a resumé of the ladies' activities program for the national convention. Mr. D. S. Nay reported that the Indiana section of IFT gave a hearty welcome to Dr. I. J. Hutchings where he was the guest speaker at the "Careers for Youth Program" held in Indianapolis.

Dr. Robert Buck introduced the speaker of the evening, Mr. Lony Ruhmann, Head, Design Testing Laboratory, Container Corporation of America. Mr. Ruhmann presented an illustrated talk on "Package Design for the Consumer." He explained how modern package design acts as the "silent salesman," replacing much of the sales contact work of past years; as a result, much more careful research must be applied to the design of packages today. Various markets such as the "leisure market," the "do-it-yourself market," the "growing population market" and "larger income market," etc., were analyzed and the influence they have on modern package design was discussed. Packages must be designed both for quick identification by the consumer and for ease in handling by the retailer. Simplicity of design is essential. He also described the equipment which is in use to analyze the effectiveness of the various design elements. Following Mr. Ruhmann's talk, the audience participated in a question and answer session.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

May 11-14	National Independent Meat Packers Association, Palmer House, Chicago
May 12-16	**Seventeenth Annual Meeting of the Institute of Food Technologists, Penn-Sheraton Hotel, Pittsburgh, Pennsylvania**
May 13-14	National Conference on Bulk Milk Handling, Michigan State University, East Lansing, Michigan
May 14-16	Second Annual Industrial Nuclear Technology Conference, Museum of Science and Industry, Chicago
June 3-8	Tenth Annual Microbiological Institute, sponsored by the Departments of Biological Sciences and Adult Education, Purdue University, Lafayette, Indiana
June 8-12	Technical Personnel Recruiting Exposition to be held in conjunction with the National Technical Career Conference. Information can be obtained from Marcus W. Hinson, 19 South LaSalle St., Chicago 3
June 9-13	Seventy-fifth Annual Convention of the National Confectioners Association, Conrad Hilton Hotel, Chicago
July 22-24	Fifty-third Annual Convention of the National Macaroni Manufacturers Association, Grand Hotel, Mackinac Island, Michigan
August 19-23	Gordon Research Conference on Food and Nutrition, Colby College, New London, New Hampshire
September 30-October 3	Fall Meeting of the AOCS, Cincinnati, Ohio
November 18-December 9	Ninth Pacific Science Congress of the Pacific Science Association, Chulalongkorn University, Bangkok, Thailand

In Memoriam

DR. ALEXANDER E. KATZ DIES

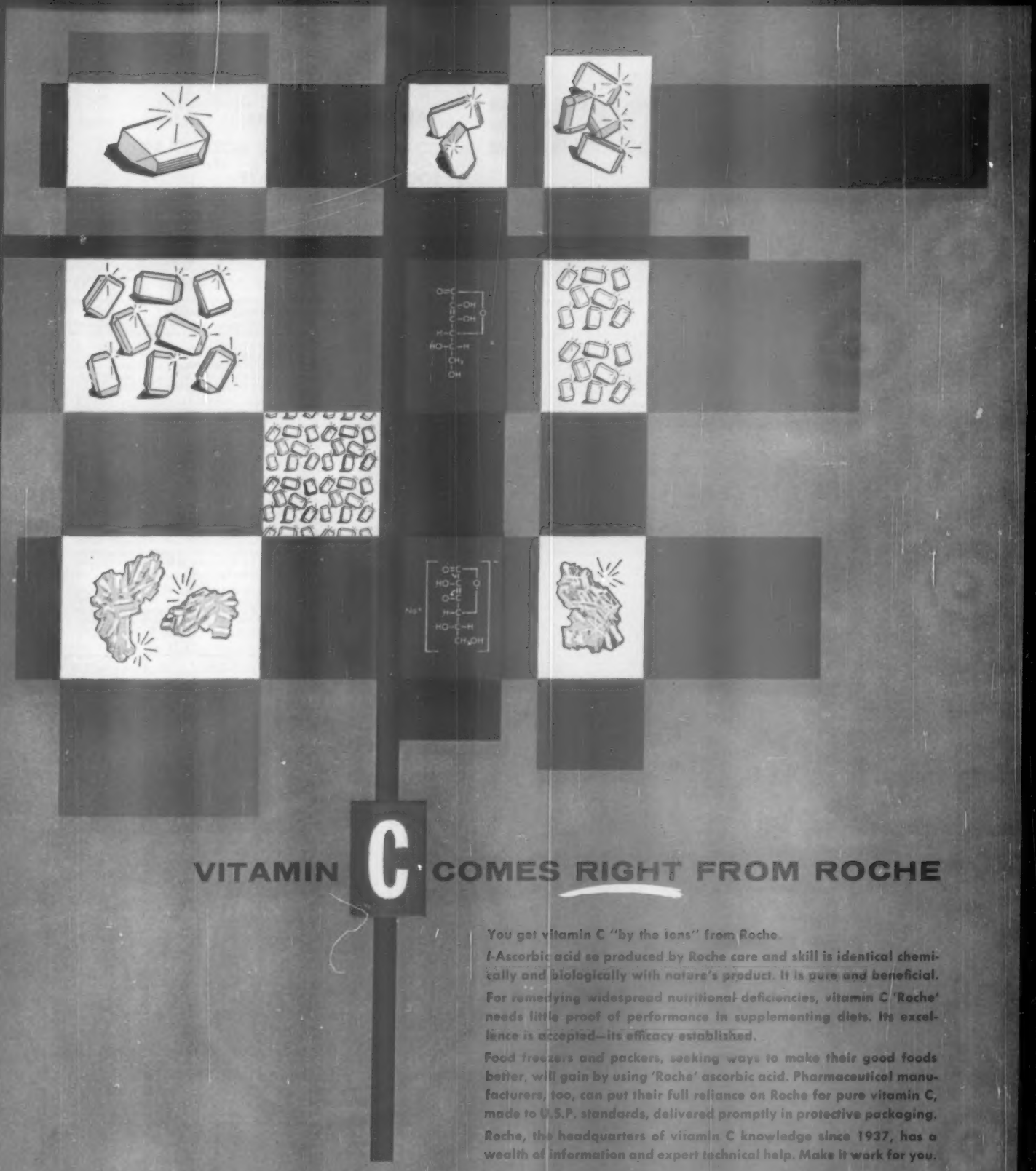
Dr. Alexander E. Katz, one of the nation's foremost food flavor and perfume chemists, and a resident of Southern California for many years, died on March 18, 1957, at home of a heart attack. Dr. Katz, born in Odessa, Russia, in 1887, was internationally famed and recognized as a leader in his field. He was a graduate of the Universities of Kharkov, Lausanne and also Columbia University. He came to the United States in 1908 after having taken over the reins of Ritter & Co., established by his father, M. Jacob Katz, in 1876.

Dr. Katz was responsible for many of the latest developments in the aromatic and fine chemical field. Through his vision and foresight, he discovered what at the time were unknown products in the industry, but today are prime factors. He worked with the Alcohol Tax Unit to establish standards on alcoholic extracts from 1917 to 1920. He was the first chairman of the Scientific Research Committee of the Flavoring Extract Manufacturers Association of the United States. During the war years, Dr. Katz served with the Office of Civilian Defense as consulting chemist in the detection of poisonous gases, and in 1947 he worked with the State of California in the determination of the possibilities of development of a varied essential oil industry in California.

As president of F. Ritter & Co. and Ritter-International, Dr. Katz made numerous trips abroad for the purpose of conducting surveys as well as sales, and also to help the industry in various countries by sharing his techniques. He was regarded throughout the industry, as well as by his many friends and acquaintances, as an authority on the application of aromatic chemicals in the flavoring and perfume industry. He wrote many informative papers which have been used as guides by his colleagues.

His hobbies, other than creating new products, were watch-making and photography. He found great personal satisfaction in repairing watches for his many friends. He also kept a running file of photographs which he took at various meetings and conventions.

(Continued on page 31)



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You get vitamin C "by the tons" from Roche.

l-Ascorbic acid so produced by Roche care and skill is identical chemically and biologically with nature's product. It is pure and beneficial.

For remedying widespread nutritional deficiencies, vitamin C 'Roche' needs little proof of performance in supplementing diets. Its excellence is accepted—its efficacy established.

Food freezers and packers, seeking ways to make their good foods better, will gain by using 'Roche' ascorbic acid. Pharmaceutical manufacturers, too, can put their full reliance on Roche for pure vitamin C, made to U.S.P. standards, delivered promptly in protective packaging.

Roche, the headquarters of vitamin C knowledge since 1937, has a wealth of information and expert technical help. Make it work for you.

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VITAMIN C

Laboratory Data Sheet

ROCHE

l-ASCORBIC ACID, U.S.P.
COATED *l*-ASCORBIC ACID—97.5%
SODIUM *l*-ASCORBATE

- The first to achieve commercial production of vitamin C by the famous Reichstein synthesis.
- Roche produces every useful type of *l*-ascorbic acid to meet virtually every manufacturing need.
- Single uniform lots as high as 3000 kilos, saving you assay costs.
- All types are uniform, readily soluble and easy to handle.
- Roche guarantees highest quality, held to rigid specifications.
- Quick delivery from strategically located warehouses.
- Packaged to protect original quality in sealed tamperpruf containers.

l-ASCORBIC ACID, U.S.P. 'Roche'

TYPES	DESCRIPTION AND USES
GRANULAR TYPE 20-60	100% (±) passes through 20 mesh. 95% is retained on 60 mesh. Similar to granulated sugar in particle size. Satisfactory for direct addition to dried granulations.
FINE GRANULAR TYPE 40-80	100% (±) passes through 40 mesh. 95% is retained on 80 mesh. A free-flowing product similar to table salt in particle size. Recommended for tablet granulations where fine powder is considered less suitable because of denser packing.
SUPERFINE GRANULAR TYPE 60-100	100% (±) passes through 60 mesh. Approximately 25% remains on 100 mesh. 45-50% passes through 100 mesh and remains on 200 mesh. 25-35% passes through 200 mesh. A very fine free-flowing crystal suitable for dry gelatin capsules or tableting. Useful in dry mixtures, food supplements.
FINE POWDER TYPE 100	100% (±) passes through 100 mesh. Produced by grinding crystalline material. Non-abrasive on tableting dies. Widely used for granulations, solutions, food supplements. Minimizes fractionation of particles in dry mixtures.
ULTRA FINE (MICRO) POWDER TYPE 325	Minimum 99% through 100 mesh. Minimum 90% through 200 mesh. Milled extremely fine. Practically devoid of abrasive action on cutting dies. Screen tests above 200 mesh are unreliable because of variations in technique, equipment, humidity, static charges, etc. Sedimentation tests and measurement of particle size in microns reveal that 60-70% of Roche material is smaller than 44 microns (equivalent to 325 mesh).
AMPUL TYPE	Very fine crystals—easily dissolved. Minimum color. Specially produced and tested for use in parenteral solutions. See Roche technical brochure "Notes on Vitamin B, and Vitamin C Parenteral Solutions" for complete details.
TYPE F	Especially produced for use in the food industry. Free-flowing, will not dust or clump, dissolves easily. U.S.P. in quality. 100% through 50 mesh. 98-99% remains on 200 mesh.

COATED *l*-ASCORBIC ACID—97.5% 'Roche'

DESCRIPTION

Coated ascorbic acid 97.5% 'Roche' is a fine, white, or nearly white powder. It is pure U.S.P. ascorbic acid powder coated with ethyl cellulose. The manufacture of coated ascorbic acid is licensed under Patent No. 2,410,417 to Roche and customers of Roche.

SPECIFICATIONS

Particle Size	100% through 16 mesh screen 75-92% through 40 mesh screen 45-80% through 60 mesh screen 35-60% through 100 mesh screen
Assay	Minimum 97.5% *l*-ascorbic acid
Identity test	Positive for *l*-ascorbic acid
Loss on drying	Negligible

USES AND DATA

Ethyl cellulose coated ascorbic acid 'Roche' has these advantages in pharmaceutical tablet manufacture:

- Small size, high potency (250-500 milligrams) tablets of light color can be made from dry granulations with very little excipient.
- Aids in eliminating chipping and capping during compression.
- Retards discoloration, mottling during abnormal storage conditions.
- Reduces contact of ascorbic acid with reactive materials.
- Rapidly available in aqueous solution for assay.
- Provides a tablet with slower release of ascorbic acid, tending to reduce localized acidity sometimes experienced with high potency tablets.

FOOD MANUFACTURERS

- Manufacturers of cured meats can use this type to advantage for retarding smokehouse activity, and for better protection in spice mixtures. It may also provide longer protection of color and flavor during storage and display.

DATA ON PARTICLE FINENESS

Based on U.S.P. XV-pages 934-5, N.F. 10, pages 702-3, *Langes Handbook of Chemistry 9th Edition, page 911

The fineness of "powders" is described in both the U.S. Pharmacopeia and National Formulary in terms which are related to the number assigned to a standard sieve made of woven wire cloth. The size of wire, and sieve opening are standardized together with permissible variation in both average and maximum openings.

Sieve Number	Sieve Opening in Microns	Sieve Opening Mm.	Permissible Variation in Average Opening Per Cent	Permissible Variation in Maximum Opening Per Cent	Wire Diameter Mm.
50	297	0.297	± 8	± 25	0.170-0.253
100	149	0.149	± 6	± 40	0.096-0.125
200	74	0.074	± 7	± 60	0.045-0.061
*325	44	0.044	± 5	± 60	0.036

Standards are established for defining the fineness of powdered chemicals, together with a technique for determining the uniformity of fineness. The types of powders described in the U.S. Pharmacopeia and National Formulary do not represent the full range of particle sizes commercially available. No procedure is given for the determination of particle size in the "ultra-fine" or "micro powder" range, sometimes referred to as No. 325. This requires a sedimentation method and measurement in microns. Ordinary sieving methods are inaccurate.

The variation possible in the standard sieves plus such variables as the motion applied to the screen and physical characteristics of the powder being screened affect accuracy and duplicability of screening tests. Particle size specifications based on mesh sizes must always be regarded as nominal rather than as strictly accurate limits of particle size and distribution.

SODIUM *l*-ASCORBATE** 'Roche'

This is the sodium salt of *l*-ascorbic acid. It is available as an odorless, tasteless, anhydrous, fine white powder or fine granular substance.

The antiscorbutic activity is in molecular proportion to *l*-ascorbic acid, one milligram of the sodium salt being equivalent to 0.889 milligram of the acid, or one milligram of the acid equivalent to 1.124 milligrams of sodium *l*-ascorbate.

Highly soluble in water—62 grams/100 ml at 25°C, 78 grams/100 ml at 75°C. Aqueous solutions are unstable, easily oxidized on exposure to air, or other factors which affect *l*-ascorbic acid.

The pH of a sodium *l*-ascorbate solution is from 5.6 to 7.+ as compared with a pure *l*-ascorbic acid solution at pH 2.3-2.5. The more neutral characteristic of the sodium salt recommends it for high dosage oral forms where gastric sensitivity to lower pH might be undesirable. It is useful in combination with ingredients which would react unfavorably under more acid conditions. Products can be buffered to a suitable pH by combining sodium *l*-ascorbate and ascorbic acid together.

Commercial forms of sodium *l*-ascorbate are not recommended for preparation of parenteral solutions. It is more satisfactory to prepare suitably buffered solutions of 'Roche' ampul type *l*-ascorbic acid, using sodium bicarbonate according to the special Roche method described in our technical brochure, "Notes on Vitamin B, and Vitamin C Parenteral Solutions."

Sodium *l*-ascorbate is of value as an antioxidant for use in comminuted meats and in curing pickles for hams, bacon, and corned beef. Because it is the salt of *l*-ascorbic acid (vitamin C), a substance naturally occurring in meats and identified in the U.S. Pharmacopeia, it may be preferred to antioxidants in the "chemical additive" class.

THESE PRODUCTS ARE FOR ANTIOXIDANT USE ONLY. IF USED IN FOOD PRODUCTS, NO CLAIM FOR NUTRITIONAL VALUE CAN BE MADE.

****Sodium d-isoascorbate, 'Roche'**, antioxidant with virtually no vitamin C activity. A white, free-flowing crystalline material. Slightly less soluble than *l*-ascorbic compounds. When replacing *l*-ascorbic acid, 23% more should be used to obtain equal antioxidant activity and 8% more when replacing sodium *l*-ascorbate. These differences are due to the presence of both sodium and water of crystallization which are inactive. Literature on request.

d-isoascorbic acid 'Roche'—antioxidant. Similar to sodium d-isoascorbate described above. Useful where acid reaction or absence of sodium is desirable. 10% less than sodium d-isoascorbate or 10% more than *l*-ascorbic acid (because of water crystallization) is required for equivalent antioxidant activity.

VITAMIN DIVISION • **HOFFMANN-LA ROCHE INC.** • NUTLEY 10, NEW JERSEY

Pacific Coast distributor L. H. Butcher Company, San Francisco, Los Angeles, Seattle, Portland, Salt Lake City • In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West, Montreal, Quebec

(Reprints available)

(Continued from page 28)

Dr. Katz is survived by his wife, Isabelle, his two sons, Leonard and Allan and his four grandchildren.

DEATH COMES TO DR. FRED W. TANNER

On Sunday, February 24, 1957, death came to Dr. Fred W. Tanner, for many years head of the University of Illinois Department of Bacteriology and the founder, in 1936, of FOOD RESEARCH. Dr. Tanner had been on leave of absence from the University of Illinois because of ill health since September 1948.

Career Notes. Fred W. Tanner received his early training, leading to a Bachelor's degree, at Wesleyan University in Connecticut. His advanced training was taken at the University of Illinois where he obtained his Master's degree in 1914 and his doctorate in 1916. In 1943, he was awarded an honorary Doctor of Science degree by Wesleyan University, his alma mater.

Professor Tanner joined the faculty of the University of Illinois in 1915 after having served as a member of the Illinois State Water Survey. At the University his interests were centered around bacteriology, but more specifically food bacteriology, the mycology of foods, sanitary chemistry, and bacterial metabolism. Early in his career he established an interest in scientific writing and in publications, an interest which culminated in his authorship of several books and in the founding of FOOD RESEARCH. In 1923, he was made head of the Department of Bacteriology at Illinois—incidentally, the first headship, since the department was newly established. He served in this capacity until 1948 when illness forced him to retire.

As mentioned, Dr. Tanner published widely on his research, notably, in the field of food and food spoilage. He was the author of the widely known books, THE MICROBIOLOGY OF FOODS and FOOD BORNE INFECTIONS AND INTOXICATIONS. He also contributed to the ENCYCLOPAEDIA BRITANNICA and to various reference books in the field of sanitation and bacteriology.

His editorship of FOOD RESEARCH, the journal which he founded, was conducted with zeal and competence. He attained over the several years of his editorship an unusual coverage and, for a journal just entering a somewhat undefined area of scientific interest, an unusual number of outstanding articles. Several of these articles have become classic references, as the *literature cited* sections of many a review article in the field of bacteriology, biochemistry, and sensory testing will show. Much of the early work on food flavor, for example, appeared in FOOD RESEARCH.

Participation in Professional Societies. Dr. Tanner played an active role in the professional societies that pertain to food technology and science. A charter member of the Institute of Food Technologists, he was also its president in 1945. He was a member of the Society of American Bacteriologists, of the American Chemical Society, and a member and Fellow of the American Public Health Association. Dr. Tanner not only worked at the national level in promoting the work of the professional societies; he was also cognizant of the importance of more local organizations. For example,

(Continued on page 34)

NIAGARA "NO FROST"

25 Years' Successful Experience

★ Always full capacity refrigeration and freezing.
★ "No Frost" removes moisture as fast as it condenses.
★ Save power, reduce costs; protect frozen food quality.

Write for Niagara Bulletin 105

NIAGARA BLOWER COMPANY

Dept. F.T.-5, 405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities of U. S. and Canada

A HEALTH *plus* ON YOUR LABEL

● Every meal she sets on her table must meet two basic requirements . . . it's like second nature to her: a meal must be *appetizing* and *health-providing*. With these goals in her subconscious, what happens in the store?

The grocery store is the proving ground of competition. *Hundreds of powerfully advertised brand names compete for her favor,* for her judgment of what will provide appetizing, health-providing meals. That's when your food product needs *a plus on the label,* a signal to her health-consciousness!

"Vitamin Enriched," "Vitamin Fortified." Those signals, those words can make a big difference today in moving *your product* to her table. Why not let a Pfizer representative tell you *in his words* the full details on how Pfizer vitamins can significantly increase your product's sales potential. Pfizer has been a major vitamin research and production center since the first vitamin was commercially produced.

Here are just 3 examples of food products that are increasing sales with Pfizer vitamins:

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(Continued from page 31)

he was instrumental in establishing the Society of Illinois Bacteriologists and was president of the group for two years.

Dr. Tanner received many honors during his career, the doctorate of science, as mentioned, and the Stephen M. Babcock Award of the Institute of Food Technologists.

As a testimonial for his work in training students and in increasing the prestige and status of the profession to which he devoted his career, the Fred W. Tanner Memorial Fund has been established. A memorial in the form of a portrait will be placed in the Bacteriology Department of the new Biology Building at the University of Illinois. Contributions are being received by the Treasurer of the Tanner Memorial Fund, Dr. F. M. Clark, 726 S. Foley Street, Champaign, Illinois.

ANNUAL MEETING ANNOUNCEMENTS . . .

The Curtain Goes Up May 12

UNDER THE GENERAL CHAIRMANSHIP of Dr. I. J. Hutchings the Seventeenth Annual Meeting of the Institute of Food Technologists will get under way in Pittsburgh May 12-16, 1957. The committees have worked long and hard to make this meeting a new high in attendance, interest, and professional profit. The general session, which opens the annual meeting, begins at 9 a.m. in the Ballroom of the Penn-Sheraton. Dr. C. R. Stumbo, chairman of the Pittsburgh Section, hosts for the meeting, will welcome the delegates and their friends to Pittsburgh.

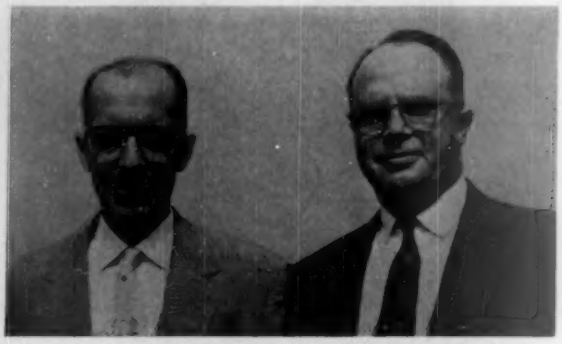
I. J. Hutchings

President George F. Garnatz delivers his presidential address at 9:25 a.m. He will review the achievements of the Institute during the year and briefly discuss the future directions of the Institute. George F. Garnatz has conscientiously and ably furthered the work of the Institute during his tenure of office. He has been outstanding in his efforts to get the "grass roots" point of view from the leaders of our far-flung organization. In a day when the technical manpower shortage in the food industries, in the teaching profession, and in Government work is a critical one, he has given particular attention to this aspect of Institute activities, notably his participation in the Indiana "Careers in Food Technology Day." The Institute of Food Technologists has been fortunate indeed to have had the devoted services of President Garnatz during the 1956-57 administrative year.

George F. Garnatz

Two noted speakers will address the general session. Mr. L. B. Smith, President, Thorofare Markets, Inc. will speak on "Planning for Tomorrow" and W. S. Lampe, Editor, Pittsburgh *Sun-Telegraph*, will discuss "Roads and You Tomorrow".

The excellent technical program provided for the Pittsburgh meeting needs no detailed description here. A full account, including abstracts of the papers, appeared in the April issue of FOOD TECHNOLOGY. For the hard work that resulted in this fine program, the appreciation of the Institute is due to co-chairmen, Drs. Buck and Stumbo.



R. E. Buck C. R. Stumbo

From any angle that you view the Pittsburgh in '57 Meeting—from the point of view of the young careerists looking for new contacts, the "old pro's" seeking new information on a new technique or a new product, the food technologists who wish to know what the flavor companies, the food machinery firms, the scientific instrument companies, the chemical products manufacturers are doing that's new and interesting—Pittsburgh is the place to be in mid-May, the 12th to 16th.

GOURMET'S DELIGHT

The IFT members who attend the 17th Annual Meeting in Pittsburgh, May 12th to the 16th, will have the opportunity to feast as they have never done before. Entertainment highlight of the convention will be the "Gourmet's Delight," a sumptuous buffet to be held on Monday evening, May 12th. Supervising this splendid

(Continued on page 40 following technical papers)

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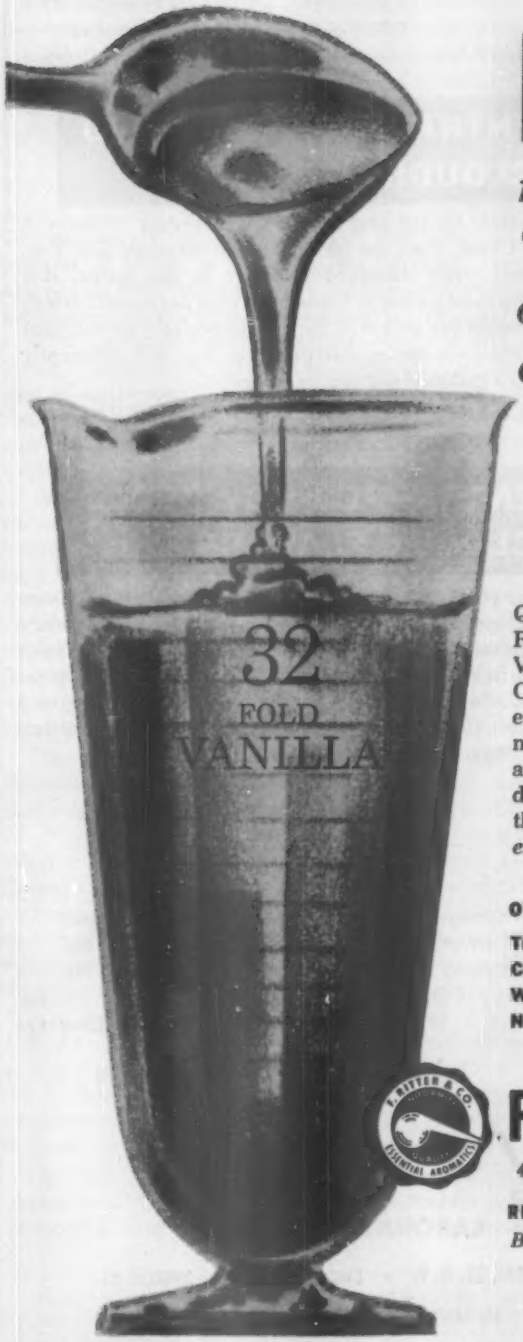

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Florasynth being one of the first companies to manufacture powdered flavoring materials, we list below descriptive details of what we feel to be the finest type of New Entrapped Powdered Flavors. Features of these New Entrapped Powders are (1) as high as 50% oil content by weight. (2) Instantly dispersable. (3) Non-hygroscopic. (4) Extremely economical. Shelf life studies have indicated excellent results.

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Manufactured and designed for use in Powdered Drinks, Gelatin Desserts, Cake Mixes, Pie Fillings, Puddings, Beverage Bases, Pharmaceutical Products, and wherever dry flavors can be used to good advantage.

Apple Imitation
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Lemon
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Orange
Pineapple Imitation
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Root Beer
Strawberry Imitation
Tutti-Frutti

Other Entrapped Flavors Developed on Request.

Suggested uses per 100 lbs.:

Gelatin Dessert: Orange—Lemon—Lime—2½ to 3 oz.
Other flavors: 1¼ to 2 oz.
Cake Mixes: 2 to 4 oz.
Puddings: 2 to 3 oz.
Powdered Drinks: (without sugar) 12 oz. to 16 oz.
(1 oz. makes 2 qts. finished beverage)
Pharmaceuticals (such as aspirin) 2 to 4 oz.

Standard Packing: 150 lb. containers

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Available for the first time to the Beverage Industry, a Dry Cloud. Does not contain any brominated oils. Two pounds when dissolved in water to one gallon will produce one gallon of Standard Cloud Solution of which one ounce per gallon of Syrup will produce an excellent suspension in the finished product. ¼ oz. will sufficiently cloud 1 gallon of finished beverage.

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After years of research our Flavor Specialists have now developed Powdered Cloudy Flavors which will produce on dilution a finished beverage simulating fresh juice both in appearance and flavor. They are uniform powders which will not separate on dilution, will give a perfect Cloud and will not form a ring in the finished beverage.

Cloudy Orange
Cloudy Lemon
Cloudy Lime
Cloudy Lemon-Lime

Suggested Uses:

Syrups ..... ½ oz. per gal.
Lemonade Mix ..... 6 to 8 oz. per 100 lbs.
Lemon Bar Mix ..... 6 to 8 oz. per 100 lbs.
Powdered Drinks (without sugar) ..... 2 to 2½ lbs. per 100 lb. Mix—1 oz. makes ½ gal. Finished Beverage

Standard Packing: 150 lb. containers

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The Plastometer—A New Development in Continuous Recording and Controlling Consistometers[a, b, c]

Dave Eolkin
Gerber Products Company, Oakland, California

(Manuscript received January 11, 1957)

INVESTIGATIONS HEREIN REPORTED resulted from efforts directed toward the establishment of continuous line production methods for purées. All Gerber puréed products are currently adjusted for proper consistency through the use of Bostwick or modified Adams *(1)* consistometers. E. P. Bostwick of the U. S. Department of Agriculture developed the former instrument in 1938, and it has since been given official status for use in consistency grading of puréed products such as tomato catsup. Both the Adams and the Bostwick instruments are very simple devices which measure the amount of slump or flattening out of purée over an established time interval. They are easy to operate and seem to correlate excellently with subjective quality.

It is important to note that both the Bostwick and Adams methods are empirically founded. The derivation of mathematical equations describing Bostwick or Adams Consistometer performance would be very difficult; yet, both have found wide application in the food industry for the previously mentioned reasons—ease of operation and good correlation with consistency as the consumer senses it. This acceptance is all the more interesting when one recognizes the fact that many well built and mathematically calculable *viscosimeters* are commercially available. This laboratory's experience and that of others in the field has generally been that viscosimeters do *not* measure the same properties as do Bostwick and Adams devices and that the latter do a much better job in indicating actual consumer preferences for consistency.

This basic difference between viscosimeters and consistometers is not merely one of terminology but of performance as well. This has been shown by Davis, De Weese and Gould *(2)*. They presented data showing poor correlation between consistometers such as the Bostwick or Adams on the one hand and viscosimeters such as Stormer or Efflux Tube on the other. The Bostwick and Adams consistometers correlated well with each other. The Stormer and Efflux Tube Viscosimeter were another correlating pair. The Bostwick and Adams instruments are well suited for batch method operations. They cannot, however, be effectively used in a continuous, automatic line. Our goal, therefore, was to develop a continuous recording and controlling consistometer which would correlate well with the Bostwick or Adams Consistometers.

The Davis, De Weese, and Gould *(2)* line of experimentation was extended to other viscosimeters in our laboratories and it became apparent that the problem of correlating continuous measuring viscosimeters with hand type consistometers had theoretical roots and that simple redesign or adjustment of a viscosimeter shearing element would not solve it.

THEORY

Purées and many other semisolids or semi-liquids differ from normal liquids by being capable of reversible, isothermal solid-liquid transformations when subjected to shear forces. The degree, direction, sharpness and other characteristics of the transformation are directly related to the specific system under investigation and to the method of shear force application. One of the consequences of such behavior is that the viscosity coefficient is no longer a constant as it is in true liquids but is a variable function of the rate of shear. This difference is graphically illustrated in Figure 1. A single viscosity determination at

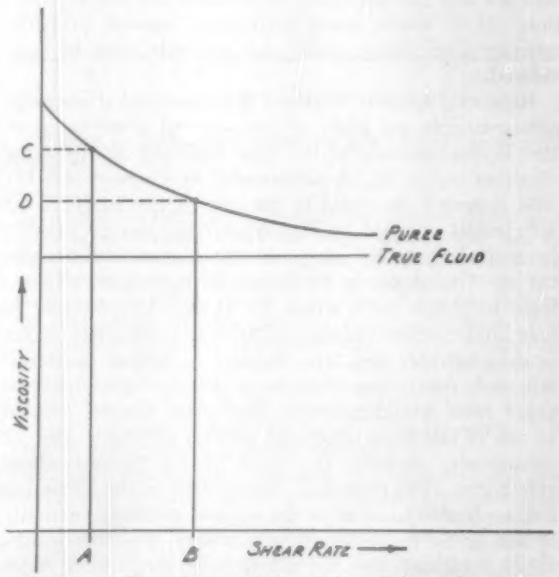

Figure 1. Flow characteristics of true fluids and purees.

any rate of shear below turbulence will accurately describe the rheological properties of a true, normal, liquid. A single measurement *cannot* accurately describe the properties of a purée. A classical, but erroneous approach, has been to pretend that the purée is a true liquid, measure its viscosity at a *single* selected shear rate, and then assume or hope that the measurement is at least proportional to the real flow behaviour of the purée. This approach is, therefore, based on two assumptions—first, that one deals with a true normal liquid and, second, that the assumption is probably in error but that enough proportionality exists between the

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 12, 1956.
[b] The Monsanto Award paper for 1956.
[c] Patent applications are pending.

measured and real properties to make the measurements of practical value.

In actuality, the single point method, viscosity measurement at a single shear rate, tells one nothing about slope or height of the curve and in some situations it can be badly misleading. It is impossible for a single point instrument to show high linear correlation with consistency no matter how the tube, disk, cup, cone or falling ball is designed. The late Henry Green had the following comment to make in his book *(3)* on industrial rheology, "Unfortunately, the single point method is invalid for non-Newtonians. Nevertheless, many rheologists use such a procedure for non-Newtonians. They attempt to make their measurement valid by calling it "apparent viscosity". Now apparent viscosity is *the viscosity a material would have if it were a Newtonian,* but a non-Newtonian is never Newtonian. Therefore, *apparent viscosity* is, in truth, a myth derived from an entirely hypothetical consistency curve.

Retention of the apparent-viscosity concept has probably done more to create confusion in the minds of plant technologists and to delay rheological progress in industrial laboratories than any other factor, except the unfortunate non-linearity of the plastic-flow curve."

This statement and our own previous discussion contain not only the kernel of the problem but also its solution. If a single point instrument cannot properly measure consistency, multipoint methods must be considered.

Referring again to Figure 1 it is seen that if viscosity measurements are made at two selected shear rates, A and B, the viscosity of the true fluid will be the same at either A or B. A differential in viscosity (C-D) will, however, be found in the case of the purée. This differential, divided by the shear rate interval (B-A), is equivalent to the slope of the viscosity-shear rate curve. The slope, in turn, can be mathematically related to plastic yield stress, S. It may be pertinent to note that neither viscosity differential nor yield stress is demonstrable for true fluids. A means of simultaneously measuring viscosity of purées at two different shear rates would therefore yield data directly related to one of the most important criteria of plastic flow or consistency; namely, the slope of the viscosity-shear rate curve. The principles enumerated in the foregoing are applicable to most of the various methods currently in use for the measurement of viscosity. In other words, tubes, rotational devices, falling balls, etc., can be used, provided measurements are simultaneously made at two different shear rates. An instrument incorporating these principles is described in the present article.

EXPERIMENTAL

Certain design considerations and relative availabilities of necessary secondary instrumentation influenced the decision to base the proposed differential shear rate consistometer on tubular flow.

Figure 2 diagrams the complete Plastometer which incorporates a 4-tube flow bridge consistency sensing element. One half of the sample flow enters a short narrow tube, A, and then proceeds into a long wide tube, B. The other half enters a long, wide tube C and exists through a short narrow tube, D. Tubes A, B, C and D are sized so as to be identical in flow resistance to a true fluid as calculated by the Poiseuille equation:

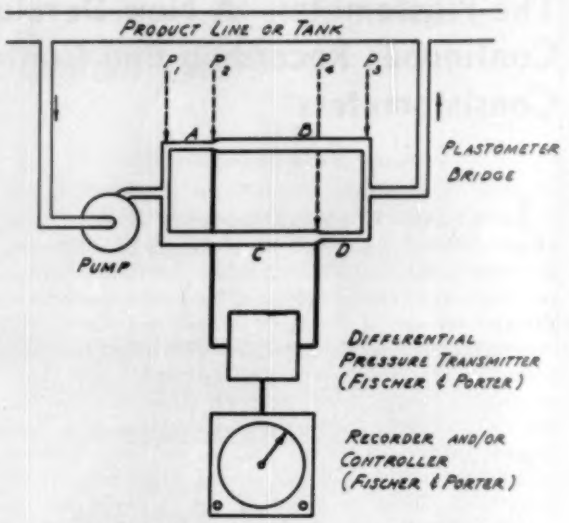

Figure 2. Continuous consistency measuring system.

where V/t = flow volume per unit time

$$V/t = \frac{\Pi\ Pr^4}{8l\eta}$$

where V/t = flow volume per unit time
P = pressure differential across the tube
r = radius of the tube
l = length of the tube
η = viscosity coefficient of the liquid.

The smallest tubing diameter in the bridge must be of sufficient size to easily pass the particulate matter in a purée. A survey of Gerber strained and junior baby foods showed that this requirement would be met if the short narrow tubes in the bridge were at least ¼ in. in diameter.

From Figure 2 these further equations can be derived to describe flow resistance and its measurement:

(1) Let $\Delta P' = (P_2 - P_3) - (P_1 - P_2)$

(2) $\Delta P'' = (P_1 - P_4) - (P_4 - P_3)$

Either $\Delta P'$ or $\Delta P''$ represent the difference in pressure differential which results from passage of the sample liquid or purée through 2 differing zones of shear. For a true or Newtonian fluid, because of construction to equivalence in flow resistance of the 4 tubes:

(3) $P_1 - P_2 = P_2 - P_3 = P_1 - P_4 = P_4 - P_3$

(4) and $\Delta P' = \Delta P'' =$ zero.

A purée of the type normally encountered in the food industry will be more resistant to flow at lower shear rates than at higher. The smaller narrow tubes in the bridge are zones of relatively higher shear while the longer wider tubes are zones of lower shear. It is seen, therefore, that for a purée difference in flow resistances will cause differences to arise among the pressure drops in the bridge:

(5) $P_1 - P_2 < P_2 - P_3$, $\Delta P' >$ zero

(6) $P_1 - P_4 > P_4 - P_3$, $\Delta P'' >$ zero

However, by constructed equivalence:

$P_1 - P_2 = P_4 - P_3$ and $P_2 - P_3 = P_1 - P_4$

substituting in (1) and (2)

$$(7)\ \Delta P' = (P_2 - P_3) - (P_4 - P_5) = P_2 - P_4$$

$$(8)\ \Delta P'' = (P_3 - P_2) - (P_4 - P_5) = P_3 - P_4$$

From symmetricity imposed by the bridge arrangement,

$$(9)\ \Delta P' = \Delta P'' = P_2 - P_4$$

Equation 9 shows that the cross bridge differential, $P_2 - P_4$, measures the difference in flow resistance of a purée in two different shear zones. Under constant flow conditions this difference is proportional to viscosity differential and to the slope of the viscosity—shear rate curve.

It is, of course, possible to design and construct a 2 tube, non-bridge instrument which would give exactly the same results as the bridge arrangement just described. The 2 tubes can be connected in series or parallel, but either connection requires the use of additional and expensive auxiliary equipment such as sampling pumps and differential pressure transmitters. The 4-tube bridge is easier and cheaper to build and operate and was selected for development for these reasons.

In operation, a small pump is used to circulate purée from the product tank or line through the flow bridge. The difference in pressure resulting at the two little tube-big tube junctions could, in theory, be directly measured on a simple differential manometer. For various reasons such as greater flexibility, durability, sensitivity, etc., it has been found better to link the bridge output to a differential pressure transmitter. The transmitter performs the function of subtracting the two pressures from each other and sending the difference to a recording and/or controlling pressure receiver. The output of the latter instrument is proportional to the original pressure difference. Under constant flow condition this difference is proportional to viscosity difference at two different shear rates and, therefore, to the slope of the viscosity-shear rate curve.

It should be pointed out, once again, that passage of a true liquid of any viscosity through the system will give a zero reading and that only structural fluids such as purées will influence the instrumentation.

One of the major reasons for the low incidence of tube type viscosimeters outside of the laboratory has been the "perfect pump problem". Flow rate, in the standard tube type viscosimeter, must be held constant and very little change in flow rate such as that caused by pump wear and slippage is tolerable. Change in flow rate, when it does take place, drectly affects and causes errors in viscosity reading. The Plastometer is relatively immune to fairly substantial changes in flow rate.

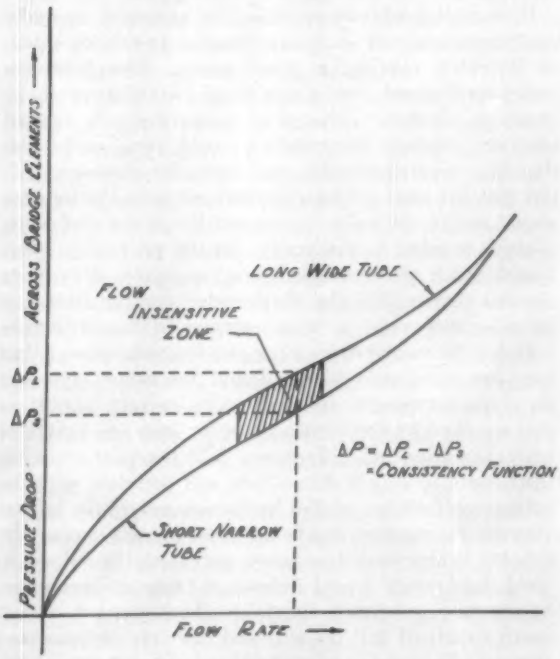

Figure 3. Plastometer flow sensitivity characteristics.

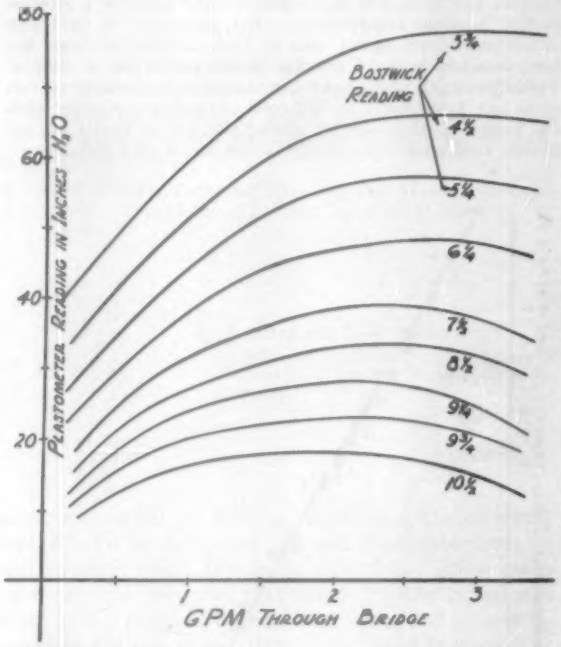

Figure 4. Plastometer output vs. flow rate. Strained apple puree at 190° F.

The reasons for this are apparent in Figure 3, which illustrates pressure drops across the "short-narrow" tube and the "long-wide" tube as a function of flow (or shear rate). Measurements made in the cross hatched area are seen to be relatively flow insensitive. Actual data, a plot of pressure differential as a function of flow rate, are given in Figure 4. With increasing flow the pressure differential rises to a maximum and then decreases. Measurements made in the maximum plateau region are thus quite insensitive to flow rate. The plateau has been found to be wide enough to tolerate at least ±10-15% change in flow rate for all products tested. The error at these extremes is usually less than 2%.

In operation, the pump appearing in Figure 2 is any good quality positive displacement sanitary pump. The pump speed must be adjusted to products for which previous information is unavailable. This is done by increasing the flow rate until the plateau center, as indicated by a maximum reading on the recorder, is reached. The flow rate or pump speed at "peak" is then characteristic for that particular product. Most baby food purées show this maximum at 1 to 3 g.p.m. at the specified tube dimensions. A slight amount of shift in optimum flow rate with change in consistency has been noted and for this reason it is desirable to establish the optimum flow rate with product at a consistency close to the center of the desired consistency range.

Figure 5 is a plot of correlative data obtained by continuously sampling a production scale, 40 g.p.m. apricot line over a 4-day operating peirod. This purée was not adjusted to a standard consistency and the Plastometer was operated as a recorder-indicator and not as a controller. Each point in the plot represents a simultaneous Bostwick measurement and Plastometer reading. The correlation coefficient was calculated and found to be 0.994. This would appear to indicate an excellent degree of

correlation with Bostwick readings. Good linear correlations with Bostwick measurements have also been found for other purées as well as for products containing starches or proteins.

Production operation of the Plastometer does not present any particular problem in sanitation. The entire unit contains only one element with moving parts, a sanitary pump. The sensing element pressure taps which open into the bridge can be continuously purged with steam condensate, water, or air. Product film buildup in the sensing element could be a problem in that it would affect accuracy and sanitation. A light film of silicone release agents such as Dow-Corning Slipicone has been found to be quite effective in the prevention of filming. Production tests have shown that continuous operating periods of as long as 48 hours on "difficult" products are possible when the bridge is pretreated as above. Cleanup is simply accomplished with water, ramrod type brush, and a mild abrasive.

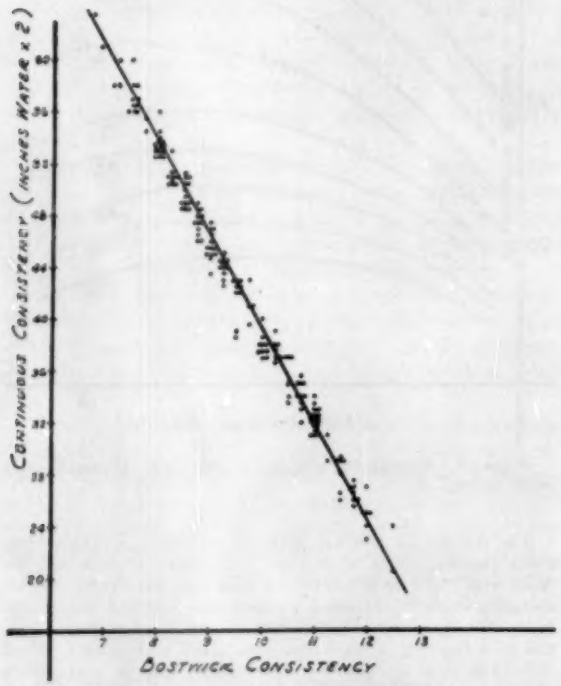

Figure 5. Apricot puree. Bostwick-continuous consistometer correlation, 30 hours on a 40-gallon-per-minute line.

DISCUSSION

It should be pointed out that a Bostwick instrument ceases to function at values so low that gravity flow does not take place.

The high end of the Bostwick range, where consistency begins to approach that of water and where rapid particle settling takes place, is equally troublesome with the Bostwick instrument. It can be expected, therefore, that extension of the date in Figure 5 to a wider consistency range will demonstrate that the "straight" line as pictured is, in reality, a curve. This wide range non-linearity is due in part, at least, to the range limitations of the Bostwick instrument itself. A more complex source of non-linearity can be developed from a consideration of purée structure. In rough approximation, purées, especially fruit purées, consist of suspensions of insoluble, discretely sized solid particles in sugar syrup. The serum phase contributes an element of true, Newtonian viscosity while the particulate matter furnishes the structural effect. A Bostwick consistometer does not differentiate between viscosity and consistency but measures the system as a whole. The Plastometer, on the other hand, ignores the truly viscous component and measures only the structural component.

The serum viscosity of most food purées is quite small in comparison to the flow resistance caused by the insoluble materials and, accordingly, correlative anomalies between the Bostwick and Plastometer methods of consistency measurements which may be attributed to this difference will also be quite small. In the extreme case of a purée with both the structural and truly viscous components of similar magnitude it *is* possible to unbalance the tube system and measure the gross effect on the Plastometer. The degree of unbalance necessary will be a direct function of the amount of viscous effect one desires to measure. As a matter of fact, a Plastometer built with unbalanced tubes will easily and accurately measure the viscosity of completely Newtonian or true liquids. The unbalance is most advantageously created by reducing the length of the high shear narrow tubes below theoretical equivalence in resistance to the low shear, wide tubes.

The fact that the wide range relationship between the Bostwick and Plastometer instruments is curvilinear leads one inevitably to question as to which one is "right". This is a very complex question and can only be answered, in the food field, by measuring the degree of correlation between subjective quality as measured organoleptically and the objective data which both the Bostwick and Plastometer instruments yield.

It is experimentally possible, for example, to make up a sugar syrup of such concentration to exactly equal, in Bostwick reading, a peach purée. The Bostwick instrument would thus judge these two systems to be identical in their rheological properties. A human observer, without instruments, could very easily distinguish, organoleptically, and describe rheologic differences between the two systems while a Plastometer would assign the value of zero to the syrup and some positive number to the purée. In the previously mentioned peach purée—sugar syrup example, it is quite obvious that neither the Plastometer nor the Bostwick consistometer yield a "true" picture of the difference between the two systems since one instrument says that they are completely identical and the other says that they are completely different. The *correct* answer is that supplied by the human observer who sees points of both similarity and difference. It is the goal of either instrument to supply data which will correlate with the subjective findings of the human observer. It is true that the Plastometer can be adjusted by unbalancing the tubular bridge in the manner previously described to yield data which would indicate a finite difference between the sugar-peach examples. The question of how much to adjust still remains and can only be answered through the medium of coordinated organoleptic panel-Plastometer experiments.

Much of the foregoing has been devoted to some of the theoretical aspects of the Plastometer. As a production consistency controlling instrument for use in the food field it will be required to control the addition or subtraction (by evaporator) of water to a set point over a very narrow consistency range. Its practical utilization in this manner has been demonstrated in production scale experiments in which continuous control to plus or minus 0.5 Bostwick units was easily accomplished.

SUMMARY

The Plastometer, a differential shear type flow bridge capable of continuously measuring consistency, has been described. Good correlation of the Plastometer with accepted industrial consistometers such as the Bostwick and Adams has been found.

Acknowledgments

The suggestions of various members of Gerber Research Staff and the encouragement and financial support of the work by our superiors and the Gerber Baby Foods Co. in general is herewith acknowledged. We also wish to thank, in particular, Mr. Gene Allard who had a prominent part in the actual construction of prototype Plastometers.

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Use of the Jacketed Room System For Cool Storage[a]

C. P. Lentz and E. A. Rooke
Division of Applied Biology, National Research Council, Ottawa, Ontario, Canada

(Manuscript received November 26, 1956)

Results from jacketed room tests made at cold storage temperatures *(2)* indicate that the jacketed room should have advantages over the conventional type of room for cool or above-freezing storage, particularly for fruits and vegetables. Most important of these advantages would be high relative humidity since the quality of many fruits and vegetables is reduced by water loss during storage. The uniform temperatures obtained with the jacketed system should also be of importance since a small change in temperature affects the storage life of some products sharply.

In the jacket system the room is cooled by air circulating through a jacket or envelope entirely surrounding the room (Figure 1). Since the cooling air stream does not come into direct contact with the room air, relative humidity, spatial variations in temperature, and air movement in the room are not directly dependent on external heat flowing into the room or on the operation of the refrigeration system. With no internal heat load, relative humidity is directly dependent on the temperature of the coldest wall surface, and hence on the amount of air circulated in the jacket. The jacket system also prevents condensation of water vapor in the insulation of the room and reduces frost formation on refrigerating coils, problems of particular importance in cool storages where much moisture is given off by produce.

The main problem to be investigated in the use of the jacketed system was the effect on relative humidity and room temperatures of internal or "live" heat loads due to respiration of stored produce. Condensation of moisture given off by produce with a vapor pressure essentially equal to that of water, and the effect of high relatvie humidity and low rate of air movement on mold growth could also cause difficulties. Information on these problems was obtained by testing a jacketed room with a range of internal heat loads, and by storing celery in the test room. Cenery was used because it is very sensitive to temperature and relative humidity.

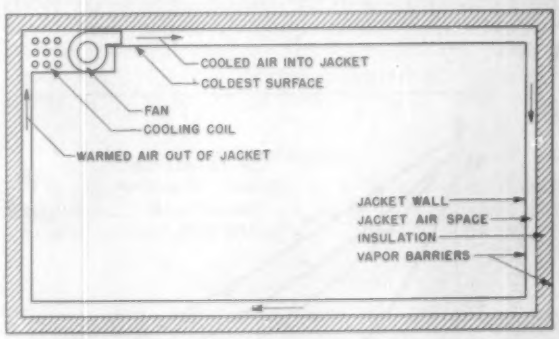

Figure 1. Schematic elevation of jacketed room.

EXPERIMENTAL

Equipment and procedures. The same room used for the cold storage tests *(2)* was used in this work. Briefly, the room is 10 x 10 x 20 ft. long (internal dimensions), and is insulated with 8 in. of mineral wool. The air jacket surrounding the storage space is 6 in. in depth on the ceiling and floor and 2 in. deep on the walls. Structural members in the jacket air space were designed to act as guide vanes or splitters, and dampers in the walls of the jacket can be adjusted to give further control of air circulation. The walls and ceiling of the jacket are made of vapor-proofed ¼ in. plywood and ½ in. wood fiber insulating board and 1 in. thick vapor-proofed plywood is used on the floor. Drip trays made of ¼ in. thick plywood were installed 6-8 in. below the ceiling for the celery storage test.

[a] Contribution from the Division of Applied Biology, National Research Council Laboratories, Ottawa 2, Canada. Issued as N.R.C. No. 4310.

Temperatures were measured with thermocouples: 27 were used in the room air, 14 on room surfaces, 6 in the inlet and outlet of the jacket, and in addition, 14 were located in heads of celery during the storage test. Drying potential in the room was estimated by calculating relative humidity based on coldest surface temperature. Relative humidity was also measured gravimetrically (by chemical absorption) during the celery storage test.

The range of heat loads tested (up to 2500 B.t.u./hr.) was greater than would be expected in practice so that the results would be applicable to rooms having a smaller surface-to-volume ratio than the test room. Since the low temperature tests previously mentioned had shown that direction (top-to-bottom or bottom-to-top) and amount of air circulation in the jacket affected room conditions, tests were made with high (1200 c.f.m.) and low (600 c.f.m.) rates of circulation in both directions. The effect of forced air circulation inside the room (provided by an 8 in. office fan) was also tested.

For the celery storage experiment 200 crates of Salt Lake celery, hydro-cooled to 40° F., were stacked 4 crates high in the room with 2 in. dunnage strips to allow air circulation on 4 sides of each crate. The air in the jacket was circulated from top-to-bottom at a rate giving a 3° F. difference between entering and leaving temperatures. During the first few weeks of storage the room temperature was held at 31 ± 1° F. but freezing occurred until the temperature was raised to 32° F. More accurate measurement showed that the celery froze at 31.5° F. For comparison celery from the same lot was held in a conventional directly cooled storage operating at 32° F. with a 4° F. temperature difference between refrigerant and room air.

RESULTS AND DISCUSSION

Heat load tests. Relative humidity varied with direction and rate of air circulation in the jacket, as well as with heat load (Figure 2). The greater decrease in relative humidity with increase in heat load with bottom-to-top circulation compared to top-to-bottom circulation was due to less efficient heat transfer from the room to the jacket. Since the temperature gradient in the room surface is in the same direction as the jacket air circulation, bottom-to-top circulation causes temperature stratification and increased temperature differences in the room.

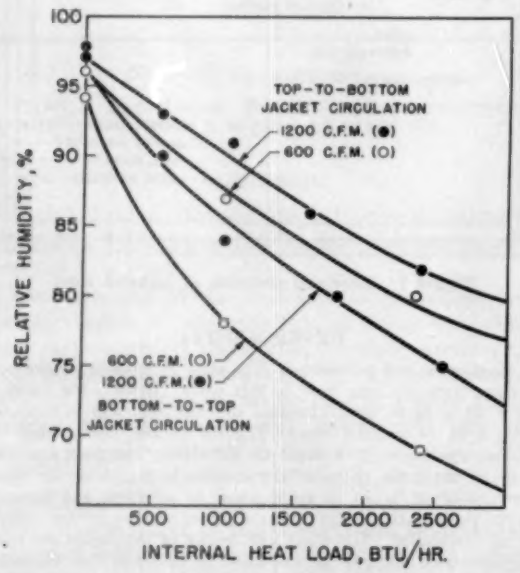

Figure 2. Relative humidity calculated from lowest surface temperature for a range of heat loads in the room.

Forced circulation in the room had little effect on relative humidity with top-to-bottom circulation, or with bottom-to-top circulation with small heat loads. With higher heat loads (2400-2600 B.t.u./hr.) and bottom-to-top circulation, however, forced air movement in the room raised the relative humidity 5-7% (from 69 to 76% with 600 c.f.m jacket circulation and from 75 to 80% with 1200 c.f.m. jacket circulation).

Spatial variations in temperature in the room also varied with direction and rate of circulation in the jacket, and with heat load in the room. Maximum spatial variation with bottom-to-top circulation ranged from less than ½° F. with no heat load to 2 and 3° F. with maximum heat load (2500 B.t.u./hr.) and rates of circulation in the jacket of 1200 and 600 c.f.m., respectively. Corresponding maximum spatial variations in temperature with top-to-bottom circulation were less than 1° F. Forced air movement in the room reduced these variations to less than ½° F. under all conditions of operation.

Jacket temperatures depended on rate of circulation in the jacket and on heat load in the room (Figure 3) but were not appreciably affected by direction of circulation in the jacket or forced circulation in the room. The relation between jacket and room temperatures for a range of heat loads in the room (Figure 3) can be used to estimate the average value of the air film heat transfer coefficient on the room side of the jacket wall. If accepted values of thermal conductivity are used for the wood fiber insulating board and plywood of the jacket wall (*4*, p. 121), and the air film heat transfer coefficient on the other side of the wall is estimated from data given by McAdams (*3*, p. 207), values of 0.9 and 0.6 B.t.u./hr.) (sq. ft.) (° F.) are obtained for the room side coefficient at jacket circulation rates of 1200 and 600 c.f.m., respectively. The difference between the values at the two rates of circulation may be due to less uniform flow in the jacket at the lower rate of circulation.

The difference between average jacket and room temperatures with no applied internal heat load (Figure 3) indicates leakage of heat from the jacket into the room, presumably through the wooden structural members in the air space and through areas with poor circulation. As would be expected, this leakage depends on rate of circulation in the jacket.

Celery storage test. The celery in the jacketed room remained in marketable condition for at least 2 weeks longer than that held in the directly cooled storage (3-3½ months compared to 2½-3 months) and was appreciably more crisp and of better color during the latter part of the storage period. Weight loss in the jacketed room averaged 1¼% per month compared to 2½% per month in the directly cooled room.

Mold growth in the test celery at any given time was not markedly greater than in the control (directly cooled) celery but mold growth and decay increased very rapidly near the end of the storage period. Most of the mold was of the genus Botrytis, although a num-

ber of other genera common in cold storage rooms were also present. Mold growth may have been accelerated by the accumulation of CO_2 (2-4% depending on door openings) in the essentially gas-tight room since certain concentrations of CO_2 have been shown to accelerate mold growth *(1)*.

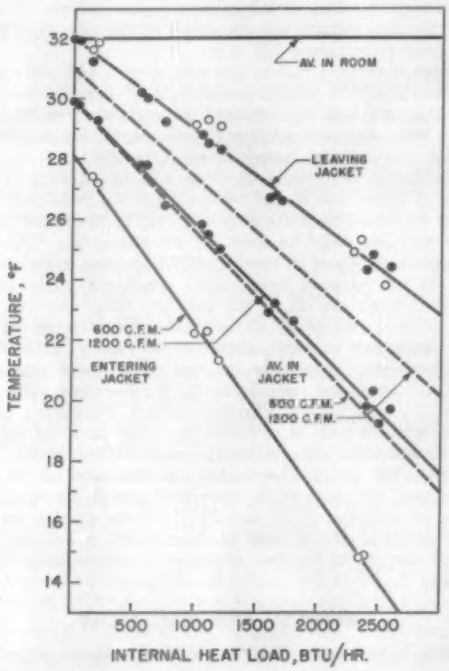

Figure 3. Jacket and room air temperatures with top-to-bottom circulation in jacket and a range of heat loads in the room.

Trimming losses in the test celery rose from 35% (wt.) at the end of 3 months to 50% after 3½ months and 65% after 4 months. These losses may have been affected by the freezing which occurred during the early part of the test.

Temperatures and relative humidities during the celery storage test (Table 1) showed that the jacketed room performed approximately as indicated by the heating tests (ompare Figures 2 and 3 at an internal heat load of 500 B.t.u./hr. with Table 1). Since relative humidity in the bulk of the room air was 100% and surface temperatures varied little, moisture condensed on the drip pans and walls as well as on the ceiling. Hence, condensation from the underside of the drip pans fell on the celery, and condensation from the walls collected on the floor. Forced circulation in the room or bottom-to-top circulation in the jacket may have reduced condensation on the walls and drip pans.

TABLE 1

Temperatures and relative humidities during celery storage test

	Average	High[1]	Low[1]	Diff.[1]
Room Air, °F.	32.3	33.3	31.4	1.9
Load Air, °F.	32.7	33.4	31.9	1.5
Load, °F.	33.1	34.0	32.4	1.6
Room Surface, °F.	31.6	32.2	31.0	1.2
Jacket, °F.				
In	27.4			
Out	30.4			
Av.	28.9			
Diff.	3.0			
Relative Humidity, %				
Gravimetric	100			
Min. Surf.	95			

[1] These figures indicate spatial variation. Temperature was controlled within ± ½° at any one point.

SUMMARY

In tests with a jacketed room in which a range of heat loads simulated the heat evolved by fresh produce stored at temperatures above freezing, relative humidity varied between 97 and 66% and maximum spatial variations in temperature between ½ and 3° F., depending on amount and direction of air circulation in the jacket, heat load in the room, and air movement in the room. These results indicate that water loss can be reduced as a factor in the deterioration of fruits and vegetables during storage by the use of jacketed rooms. Since heat loads of the size usually encountered in practice did not markedly increase spatial variations in temperature the jacketed system should be of particular value in the storage of produce requiring critical temperature control.

Celery stored in the test room remained in appreciably better condition than that held in a directly cooled room during prolonged storage. Weight loss in the jacketed room was 1¼% per month compared to 2½% per month in the conventional room.

Acknowledgment

The authors wish to thank Mr. W. R. Phillips of the Central Experimental Farm, Ottawa, for giving technical advice and arranging for the supply of celery.

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Effect of Antioxidants on the Stability of Orange Oil

W. M. Gearhart, B. N. Stuckey, and E. R. Sherwin
Eastman Chemical Products, Inc., Kingsport, Tennessee, Subsidiary of Eastman Kodak Company, Rochester, New York

(Manuscript received December 1, 1956)

THE COMPLEXITY OF ESSENTIAL OILS has caused many problems insofar as their analyses and other evaluations are concerned. Generally speaking, essential oils are made up of two major types of compounds —hydrocarbons and oxygenated compounds. In citrus oils, the hydrocarbon portion usually makes up 90% or more of the composition, and it is in the hydrocarbon portion that are found the terpenes, sesquiterpenes, and polyterpenes which are thought to be derivatives or polymers of the parent hydrocarbon isoprene *(3)*. The balance of the components of citrus oils are largely benzene derivatives, assorted straight chain compounds, and a variety of compounds peculiar to the individual oils.

Terpenes are unsaturated hydrocarbons and are especially prone to react with atmospheric oxygen. The terpene portion of citrus oils is thought to oxidize into compounds which impart undesirable odor and flavor to the oils. There is also believed to be a corresponding loss of carotenoid pigments through oxidation with a resultant loss of orange oil color upon aging. Since citrus oils are used extensively as flavoring agents, it is of the utmost importance that the quality be preserved in order to assure the food processor of receiving oils in the best possible condition and to extend the "fresh life" of the oil after its incorporation in food products.

Good manufacturing techniques are as important in producing a high quality stable oil as they are in the production of any food product. These include thorough drying of the oil, removal of trace metals, clarification and proper packaging, and storage *(1)*.

Antioxidants, in addition to good manufacturing practices, have been shown to greatly increase the storage life of citrus oils *(4)* and are now in general commercial use. The experimental work reported in this paper is concerned with an evaluation of the antioxidant effects of butylated hydroxyanisole and butylated hydroxytoluene in retarding the onset of oxidative deterioration in orange oil. Of special interest is the investigation of an accelerated objective test method whereby rapid comparisons can be made between the stabilities of different oils and between the effects of various antioxidants in protecting the oils against oxidative breakdown.

EXPERIMENTAL

Oils used in these tests were procured from commercial suppliers of flavoring agents for the food industry. Sufficient quantities of the oils were obtained for each phase of the experimental work so that the use of oil from the same batch would assure valid comparative results.

Compounds tested for their antioxygenic properties in the oils were butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) which are commonly used antioxidants, approved for use at specified levels in foods for human consumption. BHA and BHT are readily oil soluble and their addition to the oils was carried out by direct solution. It was found most convenient to make concentrates of the antioxidants in the oils to be tested and then to use the concentrates to treat the oils with the desired antioxidant concentrations. Preparation of the concentrates and treatment of the oils were carried out at room temperature (25° C.).

Storage tests were run on the oils, treated and untreated, at 25° C. and at 38° C. Samples were held in 4-ounce, clear glass jars with screw-type caps. Under these storage conditions, the samples were exposed to atmospheric conditions expected to accelerate the oxidative deterioration of the oils.

Organoleptic evaluations of citrus oils are subject to many sources of error, and it was believed that the Standard Active Oxygen Method (Swift stability test) *(2)* to determine stability of fats and oils could be used for the citrus oils. Oils being evaluated were placed in regular AOM aeration tubes and subjected to the required temperature conditions while air was bubbled through the oil at the specified rate. Ordinarily, the AOM is carried out at 99° C., but at that temperature the citrus oils are extremely volatile and oxidize too rapidly. It was necessary, therefore, to perform the test at a lower temperature which will be shown later to be 65° F. Peroxide values were run on the oils by the standard sodium thiosulfate titration method with 20 meq. of peroxide per 1,000 g. of fat being the point at which the oils developed a noticeable oxidized or rancid odor. The test for peroxides was also used as an aid in determining the end of the induction period for samples of orange oil stored at 25° C. and 38° C. Forty meq. of peroxides per kilogram of oil was used as the endpoint in this case rather than 20 meq. to be positive of rancidity before discarding any samples.

RESULTS AND DISCUSSION

Since D-limonene is the predominant terpene found in orange oil, organoleptic tests were run to evaluate the effects of adding BHA or BHT to this oil (see Table 1). Samples were evaluated odor-wise at daily intervals by an organoleptic panel until there was a majority agreement that the oil possessed a definite oxidized odor at which time the samples were declared rancid. A control sample which was held at 2° C. and used as a standard for the organoleptic tests became rancid after only 14 days of storage. The poor stability of this sample as compared with those stored at 25° C. indicated that the oil was rather highly oxidized when the tests were begun. Addition of antioxidants provided some improvement, however, with BHA, being slightly more effective than the BHT. In all cases, there was a loss of color which took place to a noticeable degree shortly after the oil was declared rancid.

An organoleptic evaluation of orange oil, treated with BHA, BHT or combinations of the two, was carried out at 25° C. and 38° C. (see Table 2). Again, the

TABLE 1

Stabilization of d-Limonene with BHA or BHT

Sample	Days to reach rancidity[1] at 25° C.	Days to reach rancidity[1] at 38° C.
D-Limonene Control	9	4
D-Limonene + 0.01% BHA	14	14
D-Limonene + 0.02% BHA	14	12
D-Limonene + 0.01% BHT	12	10
D-Limonene + 0.02% BHT	12	12

[1] By odor.

TABLE 2

Stabilization of orange oil with BHA and/or BHT

Sample	Days to reach rancidity[1] at 25° C.	Days to reach rancidity[1] at 38° C.
Orange Oil Control	71	28
Orange Oil + 0.02% BHA	195	....
Orange Oil + 0.02% BHT	179	....
Orange Oil + 0.005% BHA + 0.005% BHT	167	64
Orange Oil + 0.01% BHA + 0.01% BHT	186	94

[1] By odor.

BHA appeared to be slightly more effective than the BHT in prolonging the storage life of the oil at both temperatures. There seemed to be no advantage to be derived from the use of a combination of BHA and BHT. In all cases, there was a definite fading of the color shortly after the oil had been declared rancid by odor.

A series of evaluations was set up to determine approximately what temperature could be used in testing orange oil by the Active Oxygen Method (see Table 3). Seventy-five degrees centigrade was found to be the best of those temperatures investigated although it was felt that a slightly lower temperature would be even more satisfactory. Temperatures considerably below 75° C. resulted in excessive AOM life (hours to reach a peroxide value of 20 meq.) for untreated orange oil, and those above resulted in a radically short AOM life or a loss of the sample by evaporation.

Orange oil was stabilized with 0.02% BHA and then the treated and untreated oils were subjected in triplicate to storage tests at 25° C and 38° C. and to AOM evaluations (see Table 4). The AOM tests were run at 65° C. rather than 75° C., as previously suggested. It was believed that the tests could be run successfully at the lower temperature with less danger of evaporation of the oil. The experimental data indicates that the addition of 0.02% BHA resulted in about a 5-fold increase in the keeping quality of the oil under all the test conditions. The 65° C. temperature used in the Active Oxygen Method appeared to be quite satisfactory. Again, in all cases, there was a noticeable fading of the color shortly after the oils were declared rancid by odor and by peroxide value.

Neither sufficient orange oil nor time was available to analyze statistically this Active Oxygen Method for error. However, statistical analyses have been run on the AOM using a pure lard as the test medium. The error was found to be ± 12% when triplicate samples were tested by this method. We believe that the error in the method using a citrus oil for the test medium would be close to the above figure.

SUMMARY

Use of BHA and/or BHT to retard the oxidative deterioration of orange oil, especially when the oil is exposed to light and atmospheric oxygen, has been investigated along with an evaluation of a modified Active Oxygen Method as a rapid method for testing the stability of the oil. It is shown that BHA or BHT effectively stabilizes D-limonene and orange oil with the BHA showing slightly better results than the BHT. An Active Oxygen Method, run at a temperature of 65° C., was used as a rapid test for determining the stability of orange oil, the endpoint being 20 meq. of peroxide per kilogram of oil as determined by a sodium thiosulfate titration method. The peroxide value was also used as an aid in determining the end of the induction period of orange oil stored at 25° C. and 38° C. In these tests the critical peroxide value was found to be 40 meq.

TABLE 3

Determination of the optimum temperature for testing orange oil by the AOM

Sample	AOM temperature	I.P.V.	AOM Stability: Hours to reach peroxide value of 20 meq.
Orange Oil	30° C.	7.0	20+
Orange Oil	60° C.	7.0	11
Orange Oil	75° C.	7.0	2¼
Orange Oil	85° C.	7.0	1
Orange Oil	99° C.	7.0	< ¼
Orange Oil + 0.02% BHA	75° C.	7.0	15
Orange Oil + 0.02% BHA	99° C.	7.0	2¾

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TABLE 4

Comparison of AOM, 25° C. storage test, and 38° C. storage test on orange oil

Sample	I.P.V.	AOM (65° C.) stability	25° C. Storage		38° Storage	
		Hours to reach peroxide value of 20 meq.	Days to reach 40 meq.	Days to reach rancid odor	Days to reach 40 meq.	Days to reach rancid odor
A. Orange Oil	0	2¼	9	7	< 5	4
B. Orange Oil	0	2½	9	7	< 5	4
C. Orange Oil	0	2	9	7	< 5	4
A. Orange Oil + 0.02% BHA	0	11	48+	48+	28	24
B. Orange Oil + 0.02% BHA	0	12	48+	48+	28	24
C. Orange Oil + 0.02% BHA	0	10½	48+	48+	28	24

Effect of Coating with Starch and Starch Fractions on Storage of Dehydrated Carrot

S. Kuppuswamy * **and D. McG. McBean**
Division of Food Preservation and Transport, C. S. I. R. O., Homebush, New South Wales, Australia

(Manuscrcipt received December 26, 1956)

THE DEVELOPMENT OF OFF-FLAVORS and odors as well as "browning" in dehydrated carrot when packed in air, is well known. Most effective methods for retarding these deteriorative changes are lowering the moisture content and packing in inert gas in sealed containers.

The work of Reeve *(4)* on the changes in naturally occurring constituents of vegetable tissue during dehydration led to the experimental starch coating of dehydrated carrot.

Tomkins, Mapson and Wager *(7)* showed that carrots scalded in 2.5% starch solution retained total carotenoids better in storage than carrots scalded in water or sulphite solutions. Culinary quality was slightly better in starch treated samples. Masure, Bohart, Eastmond and Boggs *(3)* demonstrated that steam blanched carrot sprayed with 2.5% hot corn starch prior to drying had a longer storage life than unsprayed material when the products were packed in Cellophane at 84° F. They showed this improvement was less marked when the carrot was packed in air, in hermetically sealed cans.

Since previous investigations had not indicated whether the protective mechanism of starch resided in either or both of the two components, amylose and amylopectin, a 2 x 2 factorial experiment was planned in which the factors were (a) 0.5% amylose and (b) 1.5% amylopectin. The absence of both factors produced the control samples and the presence of both, the starch coated material.

EXPERIMENTAL METHODS

Starch fractionation. Potato starch was fractionated according to Schoch *(6)* by means of selective precipitation with butanol after dispersion at pH 6. After centrifugation, the butanol-precipitated fraction was obtained as a thick cream which was purified and dried using butanol. The non-precipitated fraction was flocculated with excess methanol and triturated with fresh portions of methanol until dehydrated. Yields were 22% and 78%, respectively, fixing the values of 0.5% and 1.5% in the plan.

According to Rundle and Baldwin *(5)*, the butanol-precipitated fraction was almost certainly the unbranched component of starch or amylose while the non-precipitated fraction was the branched chain component or amylopectin.

Both fractions from potato starch are relatively stable but care was taken to prevent retrogradation.

Processing. A consignment of red-cored Chantenay carrots was halved to permit replication of processing. The 4 treatments were randomized to the quarter portions of material in each replicate. Carrots were peeled in 4% lye followed by washing in a rotary stainless steel washer. The material was trimmed and passed through an Urschel stripper producing strips $\frac{1}{8}$ in. x $\frac{1}{8}$ in. in cross section. These were spread on tinned mesh trays at 1.5 lb. per sq. ft. and blanched in steam at 210° F. for 3 minutes. Samples to which coatings were applied were dipped for 10 seconds in appropriate suspensions at 150° F. After draining, the strips were dehydrated in a cross-draught drier. The range of moisture contents was 4.3 to 5.1%.

Each treatment lot was subdivided into 13 parts which were sealed in 301 x 411 cans and allotted at random to the following storage conditions; initial and 2, 4 and 6 months at 0° F., 77° F., 86° F. and 98° F.

Culinary Tests

Tasting was done according to the following scales:

Characteristic flavor:

8—Not distinguishable from good freshly cooked carrot.
6—Fairly strong characteristic carrot flavor.
4—Mild carrot flavor.
2—Very weak carrot flavor.
0—Raggy—totally lacking flavor.

Off-flavor:

8—No foreign, stale, rancid or burnt flavors.
6—Very slight off-flavor—quite acceptable.
4—Slight off-flavor—acceptable.
2—Definite off-flavor—objectionable.
0—Strong off-flavor—almost inedible.

Color:

8—Yellow-orange color—no discoloration or paleness.
6—Slightly pale.
4—Pale or slightly discolored—acceptable.
2—Definite discoloration—objectionable.
0—Dark brown.

Intermediate points were a part of the scale.

Organoleptic tests were done by an analytical panel of 7 tasters selected from a larger group who were trained for an extended period. The panel received further training prior to each storage removal.

The 4 treatments were always presented together at each session. There were 2 replicate sessions for each replicate of processing for each temperature and time of storage. Tasters used individual random orders for presentation of samples and the usual rules of coding and independence of scoring were observed. Scoring for color was done under "artificial daylight" and preceded those for flavor.

Chemical analyses. Carotene was determined in duplicate according to the method of Austin and Shipton *(2)*.

Moisture contents of the dried strip were determined by a modified A.O.A.C. method for dried fruit *(1)*, after the strips had been ground to pass a 40 mesh sieve.

Analysis of Data

Tasting scores. The data for each time and temperature of storage were treated by analysis of variance as shown for 7 tasters in Table 1.

The source of variation described as blocks included replication of processing and replication of tasting sessions; it represented sampling variation in the material which was apparently fairly uniform. This simplification was made after careful examination of all the more detailed analyses which separated the effects of replications of processing and tasting sessions. It was also found possible to carry the simplification to all interactions and present the analysis in the form shown in Table 1. This form may be described as a modified split-plot analysis and differs from the usual split-plot analysis in that tasters x blocks interaction is separated from error (2).

* Colombo Plan Junior Research Fellow from Central Food Technological Research Institute, Mysore, India.

TABLE 1

Form of analysis of variance for appraisal scores

Source of variation	Degrees of freedom
Treatments	3
Blocks	3
Error (1)	9
Total (1)	15
Tasters	6
Tasters x treatments	18
Tasters x blocks	18
Error (2)	54
Total (2)	111

It has been the experience in this laboratory that these two sources of variation are not homogeneous, the error mean square for tasters x blocks being greater than that for error (2). This means that each taster can rate a set of samples presented together with their correct relative differences, within certain limits, but that his mean level of scoring varies from session to session. It is reasonable to assume that this additional source of variation is randomly and normally distributed and to introduce a component of variance for it.

Members of the panel were consistently in agrement about the treatment differences. Error (1) was generally greater than error (2) as is characteristic of a split-plot analysis, and was used to determine the significance of treatment differences.

Generally, frequency distributions of scores were unimodal and symmetrical; this constituted a reasonable basis for the validity of the analysis of variance. In a few cases, where the operative range of scoring was restricted, treatment differences were checked by X^2 tests made on the frequencies of the various scores. These checks confirmed the conclusions made from the analyses of variance.

Thirteen analyses were done for each of the 3 characters scored.

Carotene. Carotene was expressed as mg./g. of moisture-free solids and treated by analysis of variance.

RESULTS

Tasting test scores. The analyses showed that the four treatments did not differ significantly from one another in characteristic flavor or off-flavor under any of the storage conditions. For color, treatment effects were significant ($P = 0.05$ or less) after 4 months at 98° F., and 6 months at both 77° F. and 86° F. In all such cases, samples containing amylopectin, either alone or in starch were better than amylose treated or undipped samples. This effect is shown in Figure 1. After 6 months at 98° F., there was evidence of an inconsistency due to low color scores for the starch coated samples. This effect was that amylopectin gave a better product in the absence of amylose but an inferior product in the presence of amylose.

These analyses took no account of changes in the material due to time or temperature. Figure 2 shows general treatment means for each removal. There was a general decrease with time and increasing temperature of storage, particularly with color where the only significant treatment differences occurred.

Carotene. Analysis of the data for initial and 2, 4 and 6 months storage at 0° F. showed no treatment differences and no effect of time. The remaining data were analysed separately for each temperature and showed that the presence of amylopectin retarded loss of carotene at 98° F., the effect being significant ($P = 0.05$) at all storage times. At 86° F. and 77° F. this effect of amylopectin was just below significance at the 5% level. These analyses also showed that there was a highly significant ($P = 0.001$) general decrease in carotene content with increasing storage time. When the data for the 3 highest temperatures were pooled and analysed, the protective effect of amylopectin was significant overall ($P = 0.05$). The effect of amylose on carotene retention was not significant at any time or temperature of storage.

The lower loss of carotene from samples containing amylopectin is shown in Figure 3.

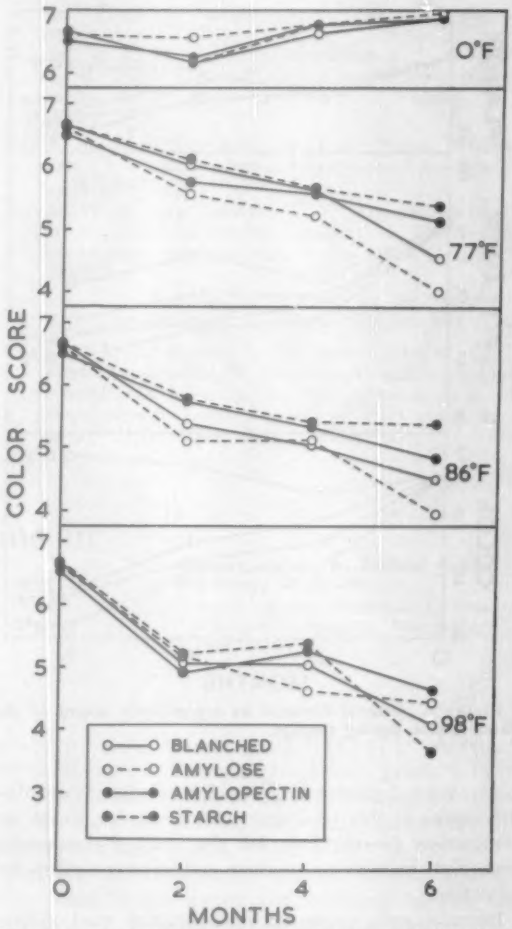

Figure 1. Improved retention of color scores in dehydrated carrot during storage by coating with amylopectin.

DISCUSSION

It is difficult to interpret the protective effect of amylopectin chiefly because the deteriorative changes in dried foods are not clearly understood. The loss of carotene is almost certainly due to oxidation. Protection might be afforded simply by the production of a coating which was impermeable to oxygen. This is uncertain, however, because handling of the strips after application and shrinkage of the coating during drying would not result in continuity of the film. In this experiment, it was considered preferable to have levels of amylose (0.5%) and amylopectin (1.5%) corresponding to proportions in the naturally occurring starch (2.0%) than to have all levels the same. However, all dipping solutions were viscous and if the protection was due only to an impervious coating, then some effect of amylose might have been expected. In no case did the amylose coated sample differ significantly from uncoated material. It seems then, that through an unknown mechanism, the branched chain component of potato starch is capable of retarding the oxidation of carotene and also the rate of "browning".

Results of starch coating agreed with those of previous workers *(3, 7)* as far as carotene loss and color

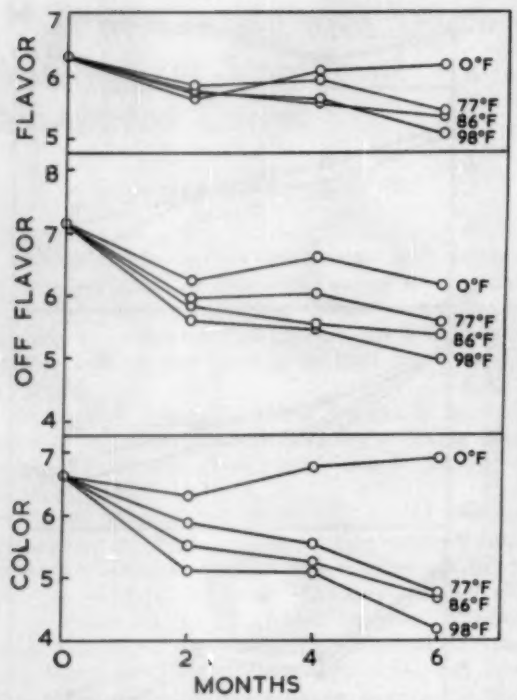

Figure 2. General decrease in organoleptic scores of dehydrated carrot during storage.

scores were concerned. The lack of significant flavor differences in this trial may have been due to its early termination (6 months), but the storage temperatures were high enough to produce differences if they were important.

Because each group of investigators used different appraisal scales, carotene losses are the only quality criteria which can be compared. Figure 4 shows the loss of carotene with time of storage. The temperatures of storage were selected as close as possible. The mean

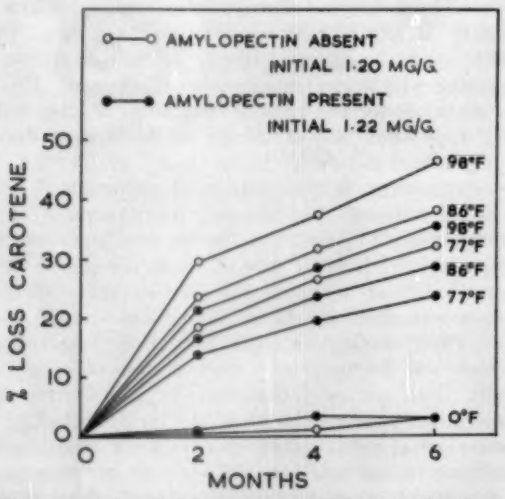

Figure 3. The effect of amylopectin in retarding loss of carotene from dehydrated carrot during storage.

temperatures were 82.4° F., [Tomkins *et al. (7)*]; 84° F., [Masure *et al. (3)*], and 86° *F.*, (Kuppuswamy and McBean, this study). These data applied to material sealed in cans and excluded Cellophane-packed carrots. From Figure 4, it is apparent that after 6 months' storage, loss of carotene ranged from 38-55% for blanched carrot, whereas for comparable starch-

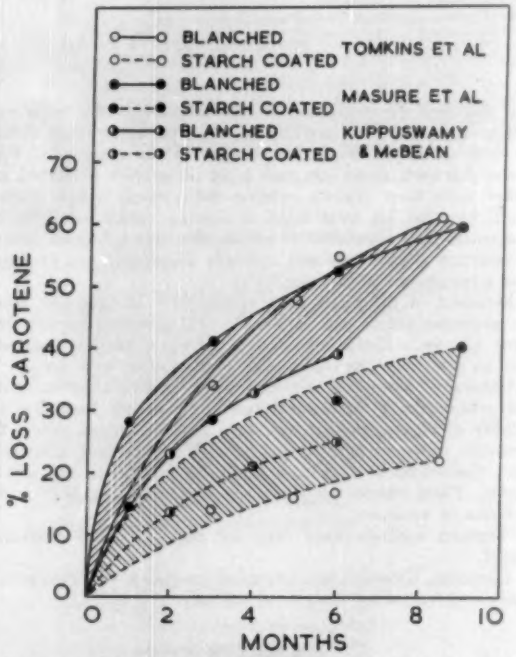

Figure 4. The effect of starch coating on loss of carotene from dehydrated carrot during storage.
Tomkins et al. Initial 1.24 mg./g. 82.4° F.
Masure et al. Initial 1.26 mg./g. 84° F.
Kuppuswamy and McBean. Initial 1.21 mg./g. 86° F.

treated samples the range was 15-30%. This suggests that starch treatment is capable of almost doubling the storage life of dehydrated carrots packed in air. This finding agrees with the conclusions of Tomkins *et al. (7)* and is in line with color scores in this trial. Masure *et al. (3)* presented few data about appraisal scores for samples stored in cans but, after 9 months at 84° F., the loss of color for blanched and starch-coated samples was 0.24 and 0.12 units, respectively. The correlation between this objective measurement and color scores was quoted as 0.850, which again suggested an approximate doubling of the storage life under these conditions.

CONCLUSIONS

There is evidence to show that the protective effect of potato starch is due to the branched chain component, amylopectin, and not to the straight chain component, amylose. Amylopectin comprises 78% and amylose 22% of the starch.

Although this and previous work have shown that starch coating retarded deterioration of dehydrated carrots, possibly doubling the life under certain storage

conditions, this improvement was not sufficient to suggest it as an alternative to packing in inert gas.

Acknowledgments

We are indebted to G. G. Coote, Division of Mathematical Statistics, C.S.I.R.O., who helped design the experiment and analysed the data. Miss E. Christie handled all tasting tests and F. Fitzpatrick supervised processing and packaging of the dehydrated product.

One of the authors, S. K., desires to thank the Government of the Commonwealth of Australia for providing a fellowship under the Colombo Plan which made his participation in this investigation possible.

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Effect of Aureomycin Chlortetracycline in The Processing and Storage of Freshly Shucked Oysters[a]

Anthony Abbey, A. Richard Kohler, and Sidney D. Upham
Food Industry Department, American Cyanamid Company, Princeton, New Jersey

(Manuscript received November 2, 1956)

Economic losses associated with food spoilage affect both producer and consumer, and sometimes limit the distribution and market for a product. Preventing or delaying microbial spoilage would tend to reduce these losses and maintain quality and freshness. The investigations of antibiotics with respect to these problems have been recently reviewed by Campbell and O'Brien *(7)* and further discussed at the First International Conference on Antibiotics in Agriculture *(20)*.

Usually a wide variety of microorganisms are encountered in food spoilage problems and therefore various compounds would behave differently. Results of the investigation of 15 antibiotics by Tarr *et al. (25)* showed that the *broad spectrum* antibiotics, Aureomycin[b] chlortetracycline (CTC), oxytetracycline (OTC) and chloramphenicol (in that order) were the most useful in retarding spoilage in fish and ground beef. Six antibiotics were evaluated by Deatherage and his co-workers *(12)* against 93 microbial strains isolated from beef lymph nodes, bone marrow and muscle *(16)*; CTC was again reported most effective. Further studies *(28, 29)* with beef included delayed refrigeration techniques.

CTC for the control of poultry spoilage was similarly investigated by Kohler, Broquist and Miller *(6, 15)* and Ziegler and Stadelman *(30)*. The shelf life of whole or cut-up chickens processed with CTC was significantly extended; OTC and TC (tetracycline) did not appear as effective as did CTC *(15)*. Acronize[c] chlortetracyline, a formulation of food grade CTC, is now being used in commercial applications by adding it to the slush-ice, chilling tank phase as practiced in poultry processing plants.

Tarr and his co-workers have carried out extensive experiments in prolonging the freshness of fish with antibiotics *(2, 3, 21, 22,23, 24, 25, 26)*. Regardless of the application technique, fish treated with CTC remained fresh for significantly longer periods. Recent studies by Firman *et al. (11)* and Tomiyama *et al. (27)* essentially confirm these findings. Farber *(10)* also evaluated CTC, OTC, neomycin and Fran-Kem in the dip-processing of various species of fish fillets and shrimp; CTC appeared to give the best results in this study.

The efficacy of antibiotics for maintaining freshness in shucked oysters has not been as well established as in fish. In addition to the inherent differences between oyster and fish tissues, a further complication is encountered in the shucking operation. Kelley and Arcisz *(14)* indicated that significant microbial increases occurred while shucking; this may be due to contamination from the mud and slime present on the shells.

Boyd and Tarr recently reported on the use of CTC in the processing of freshly shucked oysters *(4)*. In their experiments, shucked oysters were rinsed for 3 minutes in CTC solutions ranging from 2 p.p.m.-20 p.p.m.[d] and stored at 32° F. and 50° F. Results of their studies indicated that CTC did not always markedly suppress microbial development and that only

[a] Presented August 1, 1956, at the 48th Annual Convention at Miami, Florida, of the Oyster Growers and Dealers Association of North America Inc. with the National Shellfisheries Association and the Oyster Institute of North America.

[b] The trademark of the American Cyanamid Company for the antibiotic chlortetracycline is Aureomycin.

[c] The trademark of the American Cynamid Company for the food grade of chlortetracycline is Acronize.

higher CTC levels significantly retarded bacterial growth; however, the typical sour odor of spoiled oysters was usually inhibited.

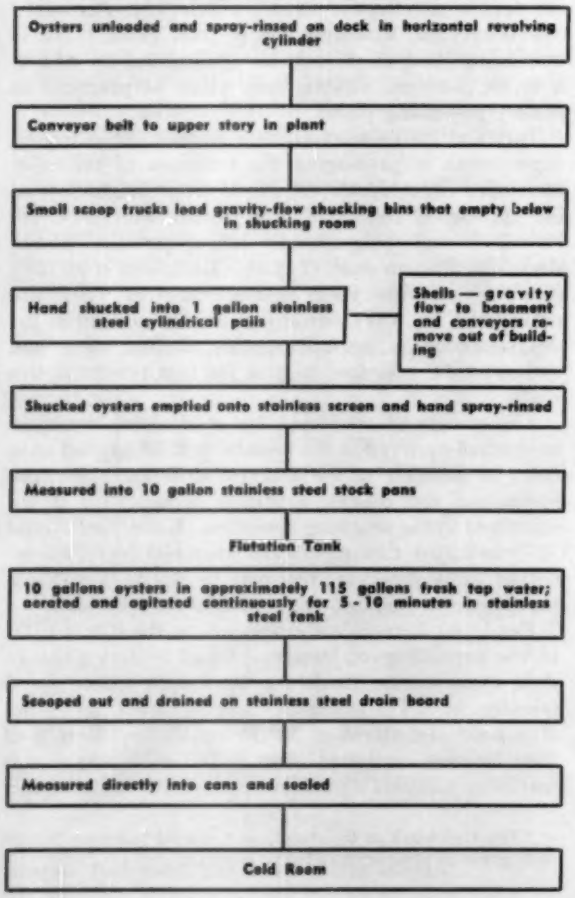
The present report further evaluates CTC in the processing of freshly shucked oysters. Test concentrations ranged from 1 p.p.m. to 30 p.p.m. with varying proportions of oysters in the processing solutions as well as varying exposure periods. Simulated commercial conditions and schedules were employed whenever possible.

EXPERIMENTAL

Materials. Shell stock was obtained from the Chesapeake Bay beds operated by the J. H. Miles Co., Norfolk, Va. with the exception of oysters from the Tred Avon River area (Oxford, Md.). Fresh oysters (standards) were commercially processed up to the flotation or blowing step (see Figure 1) and then treated with CTC. The freshly shucked oysters were treated at various concentrations (see tables), then packed in cans and sealed under commercial conditions. All cans were immediately chilled in crushed ice and forwarded to the laboratory. Samples were stored in the refrigerator (2°-4° C.; 37° F.) instead of in crushed ice, unless otherwise specified. While crushed ice temperatures (0°-1° C.) are superior in slowing down microbial development, the somewhat higher storage temperatures might be useful in estimating the quality under sub-optimum conditions. It should be noted here that temperature differences between crushed ice and ordinary refrigeration will markedly influence the spoilage pattern.

[4] NOTE: p.p.m. = mcg or γ/g. or ml.

Figure 1. Operation at the J. H. Miles Company.


Oysters unloaded and spray-rinsed on dock in horizontal revolving cylinder
Conveyor belt to upper story in plant
Small scoop trucks load gravity-flow shucking bins that empty below in shucking room
Hand shucked into 1 gallon stainless steel cylindrical pails
Shells — gravity flow to basement and conveyors remove out of building
Shucked oysters emptied onto stainless screen and hand spray-rinsed
Measured into 10 gallon stainless steel stock pans
Flotation Tank
10 gallons oysters in approximately 115 gallons fresh tap water; aerated and agitated continuously for 5-10 minutes in stainless steel tank
Scooped out and drained on stainless steel drain board
Measured directly into cans and sealed
Cold Room

Methods. Microbial counts were usually initiated within 24 hours from the processing time. In the first tests (Table 1), the oysters were held in open cans and sampled at selected time intervals; individually sealed cans were used in subsequent studies. In two trials (Tables 1 and 2) the samples for microbial counts were pre-incubated at 10° C. (50° F.) for 20-24 hours *(3)*. Under these accelerated test conditions the microbial population was stimulated prior to the evaluation. Although these conditions generally gave higher microbial counts, the use of a constant lower temperature might be more closely related to actual field conditions. On this basis, the pre-incubation step was eliminated in the subsequent evaluations. For each microbial count several oysters were homogenized in the Waring blender, usually with 3 weight-volumes of sterile water, and the resulting suspension appropriately diluted in sterile water. One ml. aliquots of the respective dilutions were plated, in duplicate, using Difco nutrient agar and desoxycholate agar or other media as indicated in the tabulations. Nutrient agar test plates were incubated 2 days at 25° C.; desoxycholate agar at 37° C. for one day unless otherwise specified.

The pH values were obtained using a Beckman Model G, glass electrode meter. Several oysters were usually ground in a hand food chopper and the pH determined.

CTC content was evaluated by procedures previously described for CTC *(5, 9, 13)*, streptomycin *(17)* and neomycin *(1)* using a modified paper disc agar diffusion method. Difco Brain-heart infusion broth was adjusted to pH 5.5 with sulfuric acid and 1% Bacto agar added before autoclaving at 121° C. for 20 minutes. The cooled (50° C.) culture medium was inoculated with *B. cereus* 5 (ATCC No. 10702) spore suspension *(8)* and 5 ml. distributed into Pyrex No. 3162 flat-bottomed Petri dishes equipped with unglazed ceramic lids. Five-gram aliquots of ground oysters were homogenized with 20 ml. of pH 4.2 acid acetone [5] and allowed to settle in the refrigerator. A similar acid acetone extract was prepared from untreated oyster tissue and used for CTC standard curve dilutions. For assay purposes S and S No. 740-E, ¼ in. paper discs were dipped in the test solutions and placed on agar plates. Not less than 6 discs (usually 9 discs) were used for each sample; 0.1 γ/ml. CTC standard was included on all test plates. Assay plates were incubated overnight at 26°-27° C. Inhibitory zones were measured on a Quebec colony counter equipped with an etched mm. scale. CTC standard curves ranged from 2 mcg./ml. to 0.005 mcg./ml.; however, 0.01 mcg./ml. was usually the lower limit of sensitivity; therefore, corresponding tissue values would usually range from 10 mcg./g. to 0.05 mcg./g. The standard curve was plotted on 3 cycle, semi-log paper (log dose vs. mm. zone size). Zones obtained with the samples under test were averaged and adjusted to fit the standard curve as determined by the 0.1 mcg./ml. CTC standard. The curve value was obtained and finally reduced to mcg./g. oyster. Values reported as negative did not show any inhibition on test plates.

When unadjusted acid acetone (pH 1.0) was used for the assay, inhibition was observed with untreated, control oysters. Other investigators *(3)* obtained similar inhibitory activity with normal, untreated fish flesh. The influence of these other factor(s) was minimized when a more alkaline (pH 4.2) acetone extractant was employed.

RESULTS

In the early trials (Tables 1 and 2) accelerated spoilage tests were conducted. The first test (Table 1) evaluated CTC concentrations ranging from 1 p.p.m. to 30 p.p.m. over an 18-day period. The tabulated values indicate the efficacy of 5 and 10 p.p.m. CTC. Differences between controls and oysters treated with CTC were quite pronounced after 10 and 14 days' storage; however, comparatively lower counts were evident in the CTC group as early as the 4th day. CTC treatments at

[5]

Reagent Acetone	650 ml.
Dist. Water	233 ml.
Concentrated HCl	17 ml.
NaOH-5 normal	40 ml. ± to pH 4.2
Dist. Water qs	1000 ml.

TABLE 1
Accelerated test
Oysters held refrigerated (2-4° C.) in opened ½ pint cans

Test conditions[1]	CTC at	Initial	1 day	4 days	7 days	10 days	14 days	18 days	Raw oysters CTC p.p.m.	
									1 day	22 days
Nutrient agar Microbial colonies/g. x 10^6	Zero control	<0.09	0.114	12	150	3400	8200	7100	0.19	0.23
	1 p.p.m.	<0.09	0.016	0.52	22	1600	1200	8500	0.22	0.28
	5 p.p.m.	<0.09	<0.009	<0.009	0.11	0.9	51	820	3.3	2.4
	10 p.p.m.	<0.09	<0.009	0.008	0.13	4.6	2.4	720	7.5	6.5
	20 p.p.m.	<0.09	<0.009	<0.009	0.034	0.14	0.75	42	13.0	17.5
	30 p.p.m.	<0.09	<0.009	<0.009	0.017	2.2	1.1	57	23.0	19.0
Organoleptic findings[2] and pH	Control	pH 6.3 A	6.5 A	6.1 A	5.8 D	5.8 E	5.6 E	5.8 E		
	1 p.p.m.	pH 6.3 A	6.5 A	6.1 A	5.9 A	5.8 D	5.8 D	5.8 D		
	5 p.p.m.	pH 6.2 A	6.4 A	6.1 A	6.0 A	5.9 A	5.9 A	5.8 C		
	10 p.p.m.	pH 6.3 A	6.45 A	6.1 A	5.9 A	6.1 A	5.8 A	5.7 B		
	20 p.p.m.	pH 6.2 A	6.5 A	6.2 A	6.1 A	6.1 A	5.8 A	5.8 C		
	30 p.p.m.	pH 6.2 A	6.5 A	6.2 A	5.9 A	6.1 A	5.8 A	5.7 B		

[1] Treatment: ½ pint oysters in 3 quarts solution; stirred for 10 minutes.
[2] Organoleptic code: A—Neutral or no off odor
B—Very slight odor
C—Slight stale odor
D—Strong odor
E—Putrid

1 p.p.m. appeared to be less effective. On the 7th day, control pH values dropped to pH 5.8 while oysters treated with 1 p.p.m. CTC were at pH 5.9, 5 p.p.m. were at pH 6.0 and 10 p.p.m. were at pH 5.9. Microbial growth after 7 days was significantly retarded in the 5, 10, 20 and 30 p.p.m. treatments; untreated controls, however, contained over 100 million colonies/g. Increased microbial counts and a drop in pH might be associated in the control series; however, the pH of oysters processed with CTC did not appear to reflect the lower microbial counts. Organoleptic findings agreed somewhat with the higher counts obtained in the controls; controls were no longer acceptable at the 7th day. In contrast, the CTC groups (5-30 p.p.m.) appeared "neutral" in odor up to 14 days' storage. CTC concentration in raw oysters tended to correlate with the potencies of the treating solutions. No significant losses were observed during the test period.

In the second series (Table 2) 5 and 10 p.p.m. CTC treatments were evaluated using equal volumes of oysters and solution. Sealed half pint and gallon containers were tested over a 24-day period. Nutrient agar colony counts after 10 days'

TABLE 2
Accelerated spoilage test
Sealed ½ pint cans held refrigerated at 2-4° C.

Test conditions[1]	CTC at	Initial	3 days	6 days	10 days	13 days	17 days	20 days	24 days
Nutrent agar colonies/g. x 10^6	Zero Control	0.035	0.21	0.85	7.5	510*	740*	1800*	66,000*
	5 p.p.m.	0.037	0.024	0.012	0.064	0.68	2.6	2.6	56
	10 p.p.m.	0.032	0.023	0.030	0.037	0.14	0.11	0.078	0.022 (650)*
Direct coliform count Desoxycholate agar colonies/g.	Zero Control	10	1900	....	100,000	PC* 7,000	PC* <400	PC* <400	PC* <400
	5 p.p.m.	16	<400	....	9,000	2,600	14,000	PC 320,000	PC 210,000
	10 p.p.m.	14	<400	....	800	3,700	14,000	PC 6,000	PC 9,000
Organoleptic[2] and pH values of ground oysters	Zero Control	pH 6.6	6.0	6.1	5.6	5.0	4.6	4.3	4.3
	Organoleptic	A	A	A	B	E	E	E	E
	5 p.p.m.	pH 6.6	6.0	6.1	6.0	5.9	5.8	5.5	5.5
	Organoleptic	A	A	A	A	A	A	B	D
	10 p.p.m.	pH 6.6	6.0	5.9	6.0	5.9	5.8	5.6	5.5
	Organoleptic	A	A	A	A	A	A	B	E
Chlortetracycline content of raw oysters p.p.m. tissue	Zero Control	0.55	0.30	0.31	0.82	0.37	0.13	0.20	....
	5 p.p.m.	4.4	3.6	4.1	2.7	3.7	1.75	2.1	....
	10 p.p.m.	8.3	8.0	7.5	5.1	4.8	3.0	2.6	....

[1] Treatment: 2 gallons oysters in 2 gallons' solution; stirred for 5 minutes.
[2] Organoleptic code: A—Neutral or no off odor
B—Very slight odor
C—Slight stale odor
D—Strong odor
E—Putrid
* Typical microbial flora replaced by small pin-point colonies.
PC = Puffed container (the clear plastic insert on cans was puffed out)

storage showed a suppression of microbial development in oysters treated with CTC at 5 and 10 p.p.m.; control counts were over 7 million/g. Desoxycholate agar coliform counts done at the same time, indicated a similar growth restriction in the CTC groups. Organoleptic and pH changes at the 10th day showed a slight off odor in the controls (pH 5.6) and neutral or no off odor with 5 p.p.m. CTC (pH 6.0) or 10 p.p.m. CTC (pH 6.0). Oysters processed with CTC were organoleptically acceptable up to the 17th day. Initial CTC levels were 4.4 p.p.m. and 8.3 p.p.m. for the 5 and 10 p.p.m. treatments, respectively; these tissue concentrations appeared to drop off on prolonged storage.

One gallon containers (snap lids) were also prepared in the second series (Table 3). These cans were commercially shipped in ice from Norfolk to Boston and back. They arrived at Princeton 11 days after processing and were then stored in the refrigerator. Microbial counts were done with no pre-incubation of samples. Twelve days after processing, the controls showed over 700,000 colonies/g. while groups processed with CTC contained less than one-tenth the number; all were organoleptically acceptable. On the 17th day controls had increased to 40 million colonies/g. and were no longer organoleptically acceptable. Microbial development in the oysters treated with CTC was restricted to less than ½ of 1% as compared to the controls; a slight off odor was detected at this time. CTC concentrations in raw oysters were about 2 p.p.m. for the 5 p.p.m. treatment and about 4 p.p.m. in the 10 p.p.m. group.

TABLE 3

One gallon containers
Test shipment in transit, etc., 11 days[1]

Test	Total days since processed	Control	CTC 5 p.p.m.	CTC 10 p.p.m.
Difco nutr. agar colonies/g. x 10^6	12	0.75	0.008	0.05
	17	40	0.16	0.03
	21	200	1.1	0.14
pH—Ground oysters	12	pH 6.0 A	pH 5.9 A	pH 5.9 A
Organoleptic findings[2]	17	pH 5.8 E	pH 5.9 B	pH 5.9 B
	21	pH 5.1 E	pH 5.7 B	pH 5.6 B
CTC content, raw oysters, p.p.m. tissue	12	0.22	2.5	4.7
	17	0.13	2.0	4.1
	21	0.14	2.1	2.8

[1] Trucked from Norfolk, Va. to Boston, Mass. and back—Railway Express from Norfolk to Princeton, N. J. NOTE: Stored in refrigerator at 2-4° C. (Princeton Labs.). Tested directly from gallon cans; *no preincubation* at 10° C.

[2] Organoleptic code: A—Neutral or no off odor
B—Very slight odor
C—Slight stale odor
D—Strong odor
E—Putrid

TABLE 4

Modified accelerated test
Oysters in sealed one-pint cans; stored at 2-4° C. (37° F.)

Test conditions[1]	CTC at	Initial	3 days	6 days	10 days	13 days	17 days	20 days
Nutrient agar colonies/g. x 10^6	Zero Control	0.011	0.027	8.22	200	290	20 (179)[3]	2.1 (180)[3]
	2 p.p.m. 5 min.	0.021	0.016	0.152	0.100	2.3	16	290
	3 p.p.m. 5 min.	0.011	0.019	0.016	0.032	0.18	18	38
	4 p.p.m. 5 min.	0.012	0.004	0.096	0.023	0.29	33	126
	10 p.p.m. 2 min.	0.022	0.049	0.028	0.049	0.18	1.2	31
	20 p.p.m. ½ min.	0.030	0.019	0.020	0.200	1.8	2.9	8.5
Direct coliform count Desoxycholate agar colonies/g. x 100	Zero Control	1.40	2.4	720	22,000	26,000	PC 8000[3]	PC 380[3]
	2 p.p.m.	0.10	1.2	17.6	64	550	680	6800 PC
	3 p.p.m.	0.30	2.8	3.6	36	240	160	670 PC
	4 p.p.m.	0.40	<0.40	4.8	12	460	520	550
	10 p.p.m.	<0.10	0.80	1.6	72	80	360	1000
	20 p.p.m.	0.40	0.80	<4.0	48	260	480 PC	60
Organoleptic[2] and pH values of ground oysters	Zero Control	pH 6.3 A	6.0 A	5.8 B	5.5 C	5.5 D	5.2 E	5.0 E
	2 p.p.m.	pH 6.4 A	6.0 A	5.8 A	5.7 A	5.6 B	5.7 C	5.8 E
	3 p.p.m.	pH 6.4 A	5.9 A	5.8 A	5.7 A	5. 7 A	5.7 C	5.8 E
	4 p.p.m.	pH 6.4 A	6.0 A	5.9 A	5.7 A	5.6 A	5.7 C	5.7 E
	10 p.p.m.	pH 6.3 A	5.9 A	5.8 A	5.6 A	5.6 A	5.7 C	5.7 D
	20 p.p.m.	pH 6.4 A	6.0 A	5.8 A	5.5 A	5.6 A	5.6 D	5.6 D
Chlortetracycline content of raw oysters, p.p.m. tissue	Zero Control	0.1	—	0.14	—	0.11	0.12	0.22
	2 p.p.m.	0.53	—	0.75	—	0.59	0.50	0.62
	3 p.p.m.	1.0	—	1.2	—	0.85	1.0	1.0
	4 p.p.m.	2.1	—	1.8	—	1.60	1.8	1.7
	10 p.p.m.	3.7	—	2.6	—	2.6	3.7	2.9
	20 p.p.m.	3.7	—	4.0	—	3.0	4.2	3.9

[1] Treatment: 2 gallons of oysters (previously "blown" for 5 minutes) in 2 gallons of solution.

[2] Organoleptic code: A—Neutral or no off odor
B—Very slight odor
C—Slight stale odor
D—Strong odor
E—Putrid

[3] Typical microbial flora replaced by small pin-point colonies.
PC = Puffed container (the clear plastic insert on cans was puffed out)

Investigations in the third series (Table 4) evaluated CTC at 2, 3 and 4 p.p.m. for 5 minutes, at 10 p.p.m. for 2 minutes and 20 p.p.m. for ½ minute. An equal volume of shucked oysters and solution was used in this experiment. Sealed one-pint cans were held refrigerated (2°-4° C.; 37° F.) and tested directly; oysters were not pre-incubated at 10° C. (50° F.) for microbial counts. Microbial counts on the 6th day of storage were over 8 million colonies/g. for the controls, whereas the groups of 2-20 p.p.m. CTC ranged from 16,000 to 150,000 colonies/g. On the 10th day control microbial counts had increased to 200 million colonies/g. while the groups treated with CTC ranged from 23,000 to 200,000 colonies/g. oyster; direct coliform counts indicated 260,000 colonies/g. for the controls and a range of 8,000 to 55,000 colonies/g. in the oysters processed with CTC. Organoleptic findings at the 10th day showed off odors for the controls while CTC groups were still acceptable. Control pH values had dropped to pH 5.5 whereas groups treated with 2, 3 and 4 p.p.m. CTC were at pH 5.7. Oysters processed at higher concentrations for shorter time periods were slightly lower in pH.

CTC levels in raw oysters were reasonably consistent throughout the test period; initial concentrations ranged from 0.5 to 3.7 p.p.m. for the treated groups. Data obtained in this experiment indicate that processing with CTC at 3 or 4 p.p.m. for 5 minutes or at 10 p.p.m. for 2 minutes would retard bacterial growth in freshly shucked oysters.

Oysters obtained from the Tred Avon River area were evaluated in sealed ½-pint cans stored in crushed ice. Lower CTC concentrations (1 and 2 p.p.m.) were used to test longer exposure times coupled with storage in crushed ice (Table 5). Microbial counts at the 13th day showed over 4 million colonies/g. for the controls whereas the groups treated with CTC ranged from 72,000-180,000 colonies/g. tissue. No significant pH differences were noted between control and treated groups; however, a definite off odor was evident in the controls whereas the oysters processed with CTC were fresh. On the 20th day, control colony counts were 4 million/g. while those processed at 1 and 2 p.p.m. CTC were substantially lower. Similar values were obtained with the oyster liquors tested. Organoleptic observations indicated off odors in the controls and, to a lesser degree, in the 1 p.p.m. CTC group; the 2 p.p.m. group still had a fresh aroma; controls and the 2 p.p.m. CTC group were at pH 6.0 while the 1 p.p.m. group read pH 5.85. After 27 days' storage, all groups gave values between pH 5.70-5.80; at 33 days the controls were at pH 5.5 and were putrid while the CTC groups, although not as acidic, had developed off odors. Desoxycholate agar coliform counts were quite variable, but did tend to increase in all groups during the test period.

CTC concentrations were evaluated throughout the study and remained fairly consistent. After 3 days' storage, the 1 p.p.m. series assayed 0.42 p.p.m. and the 2 p.p.m. group 0.46 p.p.m. At the end of the test (33 days) 0.34 p.p.m. and 0.46 p.p.m. tissue were found for the 1 and 2 p.p.m. respective treatments; oyster liquors, from both groups, ranged from 0.14-0.18 p.p.m. during the test period.

A comparison may be made between the above 2 p.p.m. treatment held in crushed ice and the same concentration held refrigerated as in Table 4. Although the oysters were obtained from different beds about one year apart, the similarity in test results is apparent up to the 10th day. After that time, the advantages of holding in crushed ice become pronounced and may account for the differences observed when aged longer.

In Figure 2 the nutrient agar counts after approximately 10 days' storage are plotted for the 5 tabulations. When possible the 5 p.p.m. CTC treatments were plotted; however, 4 p.p.m. and 2 p.p.m. were used from Tables 4 and 5, respectively. A further comparison is effected with those groups held in crushed ice (Tables 3 and 5) where the results after 12 and 13 days were plotted.

DISCUSSION

The data presented indicate that shucked oysters treated with CTC remain organoleptically acceptable for longer storage periods when compared to the untreated controls. Similar findings were reported by Boyd and Tarr *(4)* in which the sour odors typical of spoiled oysters were inhibited by CTC.

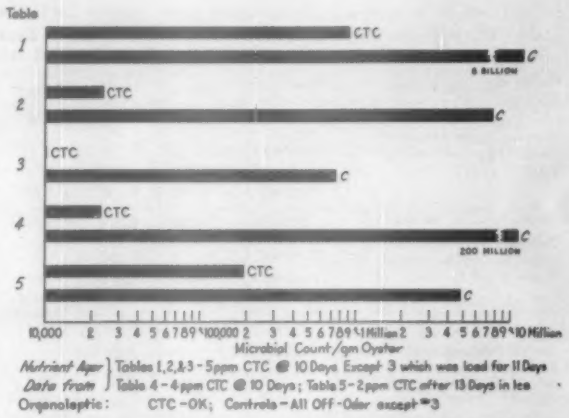


Table
1
2
3
4
5
CTC
C
8 BILLION
200 MILLION
10,000 2 3 4 5 6 7 8 9 100,000 2 3 4 5 6 7 8 9 1 Million 2 3 4 5 6 7 8 9 10 Million
Microbial Count/gm Oyster
Nutrient Agar
Data from
Tables 1, 2, & 3 - 5ppm CTC @ 10 Days Except 3 which was load for 11 Days
Table 4 - 4 ppm CTC @ 10 Days; Table 5 - 2 ppm CTC after 13 Days in Ice
Organoleptic:
CTC - OK; Controls - All Off - Odor except *3

Figure 2. Summary of data on CTC-treated oysters.

Accelerated spoilage tests or storage at higher temperatures demonstrated the greatest differences between untreated oysters and those processed with CTC. Under these conditions, microbial counts were much higher for the controls when compared with the effective CTC treatments. In some instances the microbial population appeared to change abruptly, particularly after prolonged storage of the controls. These shifts might be associated with the drop in pH and/or physical factors in the containers.

The usefulness of pH as an index of relative freshness was investigated and confirmed by Pottinger *(18, 19)*. In our study, the pH trends appeared to be less indicative than organoleptic and microbial count studies which were useful quality guides for oysters processed with CTC.

CTC concentrations of processed oysters tended to remain constant for the test period in a majority of the experiments conducted. Some activity was also obtained with control oysters and may represent other "inhibitory factors" present in the tissue; a more alkaline extractant (pH 4.2) tended to minimize this effect. CTC tissue levels were apparently influenced by the method and time of exposure in the test solutions; in these experiments, CTC solutions ranged from 1 p.p.m. to 30 p.p.m.

In contrast to these findings, Boyd and Tarr *(4)* have reported a 50-60% decrease in CTC levels over a 12-day storage period. Where comparisons were possible, the initial CTC tissue levels appeared similar to those obtained in this study despite major differences in conditions and exposure time. The storage containers, however, were notably different (sealed cans vs. waxed cardboard cartons) and may account for the variation in CTC stability results.

From the data summarized in Figure 2 oysters treated with CTC were organoleptically acceptable and contained fewer microorganisms after 10 days' storage when compared to the controls, regardless of the test storage conditions. Trial shipments, in crushed ice during transit (Table 3), further indicated the usefulness of CTC. Although both control and treated gallon containers were organoleptically acceptable on arrival,

TABLE 5
Tred Avon River oysters
½ pint sealed cans stored in crushed ice

Test conditions[1]	CTC at	1 day	3 days	6 days	10 days	13 days	17 days	20 days	24 days	27 days	33 days
Nutrient agar microbial colonies/g. oyster tissue x 10^6	Zero p.p.m. Control	0.078	0.136	0.124	0.252	4.8	4.2	4.0	0.31	1.84	....
	1 p.p.m.	0.188	0.208	0.232	0.098	0.192	0.18	0.21	1.12	0.348	....
	2 p.p.m.	0.132	0.148	0.152	0.132	0.184	0.072	0.60	0.18	1.06	....
Nutrient agar microbial colonies/ml. free oyster liquor x 10^6	Zero p.p.m. Control	0.049	0.074	0.095	0.166	0.128	2.40	4.10	0.30	1.24	....
	1 p.p.m.	0.011	0.140	0.046	0.014	0.074	0.077	0.044	0.114	0.041	....
	2 p.p.m.	0.025	0.228	0.032	0.009	0.097	0.050	0.950	0.44	0.33	....
Direct coliform count desoxycholate agar colonies/g. tissue x 100	Zero p.p.m. Control	0.34	0.40	2.52	23.8	2.38	15.4	20.4	0.11	23.0	....
	1 p.p.m.	1.56	0.58	2.68	4.0	1.94	25.8	6.0	0.44	10.6	....
	2 p.p.m.	2.04	0.06	8.00	19.6	6.18	5.96	15.9	0.90	10.2	
Organoleptic[2] and pH values of ground oysters	Zero p.p.m. Control	pH 6.45 A	6.30 A	6.25 A	6.08 B	6.05 C	5.90 C	6.00 C	5.90 C	5.80 D	5.5 E
	1 p.p.m.	pH 6.25 A	6.20 A	6.10 A	5.90 A	5.90 A	5.80 A	5.85 B	5.80 C	5.78 C	5.75 D
	2 p.p.m.	pH 6.20 A	6.12 A	6.00 A	5.92 A	5.95 A	5.75 A	6.00 A	5.75 A	5.70 B	5.70 D
Chlortetracycline content of raw oysters, p.p.m. tissue	Control	....	neg.	....	neg.	....	neg.	....	neg.	....	neg.
	1 p.p.m.	....	0.42	....	0.37	....	0.28	....	0.34	....	0.34
	2 p.p.m.	....	0.46	....	0.39	....	0.27	....	0.37	....	0.46

[1] Treatment: *Controls:* aerated 15 minutes in plain water; *CTC 1 p.p.m.:* stirred 15 minutes in Acronize solution; *CTC 2 p.p.m.:* equal parts oysters and Acronize solution stirred for 5 minutes.

[2] Organoleptic code: A—Neutral or no off odor
B—Very slight odor
C—Slight stale odor
D—Strong odor
E—Putrid

the microbial counts showed a distinct advantage for the oysters treated with CTC.

Oysters from the Tred Avon River area processed with 2 p.p.m. CTC (Table 5) and stored in ice showed similar advantages. However, at approximately the 13th day the microbial counts for the controls appeared to be higher than those held in ice from other areas.

The general observations resulting from these trials indicate that CTC would be useful in maintaining the the freshness of shucked oysters. Sealed containers held in crushed ice would appear preferable in maintaining good quality. Keeping quality differences were more pronounced when comparatively unfavorable storage conditions were used for the spoilage studies. In this manner, some of the practical problems encountered in the processing and shipping of shucked oysters were investigated. When CTC was included in the processing—preferably in a simulated "blowing" tank or as a separate dip—the oysters remained organoleptically acceptable for longer periods under somewhat adverse conditions. On this basis, CTC could be a useful adjunct to the good sanitation and shipping precautions practiced by the industry.

SUMMARY

CTC was evaluated in concentrations ranging from 1 p.p.m. to 30 p.p.m. with varying exposure times. Several trials were conducted in cooperation with commercial processors. On a limited basis, production facilities and schedules were employed wherever practical; the various proportions of freshly shucked oysters and treating solutions as well as exposure times were thus investigated. Comparatively unfavorable storage conditions were usually employed for the laboratory freshness studies. Under these conditions, the microbial counts and organoleptic findings indicated the usefulness of CTC in the processing of freshly shucked oysters.

Acknowledgment

The authors are grateful to Mr. Frank Miles of the J. H. Miles Company for making most of these experiments possible; his kindly advice and encouragement were helpful throughout the study. Especial thanks are due to Mrs. Mary Cenerino and Mrs. Doris Young for their most valuable technical assistance in the laboratory phases of each experiment.

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Direct Steam Injection for High Temperature Short Time Sterilization Of Whole Kernel Corn[a]

J. L. Vetter,[b] A. I. Nelson, and M. P. Steinberg
Department of Food Technology, University of Illinois, Urbana, Illinois

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That heat has a detrimental effect on the flavor and color of most food products has long been known. It is also known that the conventional method of sterilizing many canned foods, the batch method in a still retort, may result in overheating all the food in some cans or some of the food in all cans. Investigators have attempted to develop a successful method for sterilizing canned food at a higher temperature for a shorter time (HT-ST) and thereby minimize this effect.

The Sterilmatic Process *(6)* is an example of a procedure which has survived commercial testing. Agitation is achieved by rolling the cans on their sides. End-over-end agitation *(2, 3)* has also been accepted commercially. In the W. M. Martin aseptic canning procedure *(1, 7)* food products are rapidly sterilized by high temperature in a heat exchanger. At present the method is limited to use with foods which can be pumped and filled without damage or separation.

Sterilization by direct steam injection into the food has been atempted and reported in the patent literature *(10, 11, 12, 13, 14)*. None of these methods has found commercial acceptance. Also, none of the reports gives data describing heat penetration into the product using direct steam injection.

This study was designed to develop a process whereby solid particulate foods, such as vegetables, could be sterilized rapidly in the can by direct steam injection before sealing. Data on heat penetration using this method are also presented.

EXPERIMENTAL

Equipment. The unit developed consisted of a pressure chamber holding a brass head for direct injection of steam into the can contents and a hand can sealer for closing the cans. The head for the direct injection of the steam was designed to be used with Number 2 (307 x 409) cans. It was approximately 4 inches in diameter and 1 inch in thickness (Figure 1).

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[b] Presented in partial fulfillment of requirements for the M.S. degree in Food Technology, the University of Illinois, Urbana.

The head was mounted under the lid of the pressure chamber (Figure 2). A circular groove, about one inch at its widest point and one-half inch at its deepest point, was cut out of the top of the piece of brass. A brass plate was soldered over the open area of the groove, leaving an annular channel in the piece of brass. Two diametrically opposite 1/8-inch holes were drilled from the side of the head into the channel. Copper flange fittings were soldered into these holes.

Eight 3/16-inch holes were drilled into the hollow groove of the head from the bottom side. Steam injection tubes were soldered into these holes which were so situated that the steam entered around the edge of the can. These tubes were approximately 4 inches long. Thus, when the head rested on the open flange of a Number 2 can, the steam entered the head at the two diametrically opposite points and discharged from the 8 tubes through small openings at the bottom of the can.

A gas-fired combustion kettle was modified for use as the pressure chamber. The Number 2 can rested on a spring loaded platform inside the kettle. This spring tension caused the can to fit snugly against the head but not so tightly as to prevent exhausting air and steam from can into kettle.

The various parts of the system are shown in Figure 3. Steam enters the chamber through a flexible metal hose. Condensate and exhaust steam are removed at the bottom of the kettle; the vacuum is drawn through the same line.

The thermocouple lead wire enters the chamber through a stuffing box for heat penetration studies. The lid is raised and lowered by means of a winch. Cans were sealed with a hand can sealer.

Temperature readings were made with a Leeds and Northrup Portable Multiple Range Potentiometer, which was connected to an Ecklund thermocouple placed at the desired position in the can.

A Minneapolis Honeywell Recording Potentiometer, with special thermocouple, was used to measure the temperature in a kernel of corn at the center of the can. The instrument recorded at a rate of approximately one reading per second.

Material and preparation. Golden Cross hybrid sweet corn, used as the test material, was harvested and prepared the day of the experiment. Preparation consisted of husking, cutting the kernels from the cob, cleaning, and washing. Frozen control samples from the same corn were blanched in steam before freezing and storage at —40° F.

National Canners Association Flat Sour microorganism 1518 was used for the inoculated packs. Spoilage in canned foods due to this organism is characterized by acid formation but there is no gas production. This bacterium has high resistance to heat *(9)* and is a common cause of spoilage in canned corn. The spore crop used for inoculation was grown at 55° C. on nutrient agar with 1 p.p.m. Mn added as $MnSO_4$. The spore suspension was pasteurized at 105° C. for 5 minutes. Plate counts were made on nutrient agar with 1 p.p.m. Mn. The plates were incubated at 55° C. for 48 hours.

Methods. Procedure used for HT-ST processing of cut sweet corn follows:

Temperature of all parts of the unit was raised by passing steam through all pipe lines and the pressure chamber. The can was then placed on the platform, and the chamber lid lowered and secured. A vacuum of 25 inches was drawn. Steam was admitted to the pressure chamber. The condensate drainage

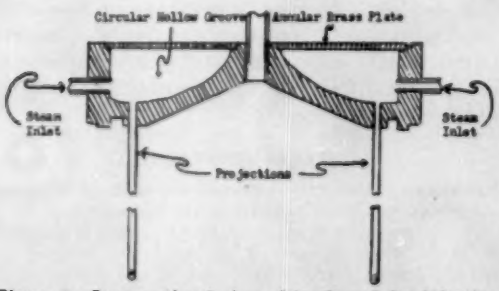

Figure 1. Cross-sectional view of head used for injection of steam into open can of food.

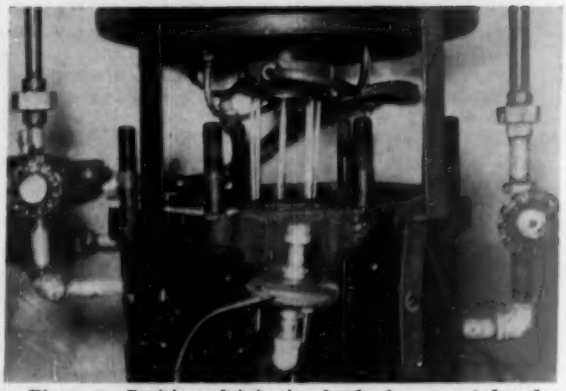

Figure 2. Position of injection head when mounted under lid of pressure chamber.

valve was opened as widely as possible while balancing the inlet steam so as to maintain a positive pressure of 27 p.s.i.g. inside the can. This was done to permit a continuous flow of steam through the corn.

At the end of the required time the pressure was rapidly reduced to zero p.s.i.g. by shutting the steam inlet and opening the drainage valve completely.

The can was removed with sterile tongs and a sterile lid was immediately sealed on the can. The can was inverted and held for 2 to 3 minutes before cooling in running water. With this procedure only 10-15 ml. of water were added to the product due to steam condensation.

When heat penetration studies were made, the same procedure was followed. The Bakelite insulation at the tip of an Ecklund thermocouple was removed thus exposing about 1/16 in. of the copper and constantan wires. A kernel of corn was impaled on the thermocouple in such a manner that the junction was in the center of the kernel. All 12 junctions in the recording potentiometer were connected to the one thermocouple so that each read the temperature at the same point. In this way a relatively smooth curve was obtained on the chart. When temperatures were read inside the can, but not at the center of a corn kernel, a normal Ecklund thermocouple was used, and readings were made on the portable potentiometer.

The corn was spread out in a shallow tray for inoculation. The spore suspension was sprayed evenly over the product by means of an atomizer. Enough corn to fill 4 cans was sprayed at one time with 20 ml. suspension. The cans were tested for acid production by the addition of several milliliters of 0.04% Bromcresol purple pH indicator *(8)*. A change of color from purple to yellow indicated that souring had occurred.

by staff members. For the zero time storage evaluations, samples were cooked 8 to 10 minutes in one-half cup of 3% salt solution; after 4 months of storage, samples were simmered

Organoleptic ratings. Organoleptic ratings were determined for 15 minutes in a similar solution. The longer time was used to insure safety for the testers. The samples were graded 1 to 10 with 10 designating *excellent* and 1 *extremely poor*. Samples were evaluated by 6 testers for flavor, color, texture, and off-flavor. The *flavor* score refers to the degree of characteristic and desirable sweet corn flavor. The *off-flavor* score refers to the degree of foreign and undesirable flavors such as "scorched" and "cobby". A high off-flavor value indicates little or no undesirable flavor. A statistical analysis of variance was performed on the organoleptic data.

Time-temperature determinations. Time-temperature relationships were determined at various locations in the can to find the slowest heating point using this system. The time required for the interior of a corn kernel to reach process temperature was determined. A heat penetration curve was made using the recording potentiometer and reading temperatures at the center of the kernel.

A series of cans were processed using an inoculum of 5,000,000 spores of NCA organism 1518 per can and process times of 75, 100, 150, and 200 seconds. These process times

Figure 3. Apparatus used for high temperature-short time sterilization of vegetables.

represent F_o values of approximately 12, 16, 26, and 36, respectively. They may be compared to the recommended F_o of approximately 20 for vacuum packed whole kernel corn processed in a still retort at 250° F. A series of cans with no inoculum were also processed for the same times. All of the inoculated cans and the controls containing no spores were stored at 130-132° F. for two periods—13 days and 4 months. At the end of the storage time these cans were allowed to come to room temperature and tested for vacuum and acid production.

Another series of uninoculated cans were processed in quadruplicate for 75, 100, 150, and 200 seconds and evaluated organoleptically in duplicate after overnight storage at 40° F. and after 4 months storage at room temperature.

RESULTS AND DISCUSSION

Results of the determinations made to find the slowest heating point between the kernels in the can are given in Table 1. Time required to reach the highest temperature, 268° F., was the same, 25 seconds, at all locations in the can. This indicates the steam was well distributed inside the can.

Similarity in come-up time throughout the can was due in part to the vacuum drawn at the start of the process. As a result of absence of air and the flow of live steam through the corn, all parts of the can were almost instantaneously heated. Therefore, no lag or "slowest heating point" was observed.

Temperature at the center of a corn kernel during the entire process of a typical trial is presented in Figure 4. That the interior of a kernel reached process temperature in about 45 seconds is shown by the curve. The combination of rapid heat penetration and high steam temperature made possible the short process time required. Figure 4 shows that a constant temperature was maintained inside the kernel during the process. Rapid cooling, from process temperature to 212° F. in about 40 seconds, is also indicated by the curve.

TABLE 1

Heat penetration into Number 2 cans of cut sweet corn

Point	Distance from side of can (inches)	Distance from bottom of can (inches)	Time to reach 268° F. (seconds)
1	1 11/16	5/16	25
2	1/4	5/16	25
3	1 11/16	2 1/2	25
4	1 11/16	3 7/8	25

Results of the high temperature incubation study are given in Table 2. Three samples possessed vacuums considerably lower than the others; no explanation can be given for this variation. Cans inoculated with 5,000,000 spores and processed for 75 to 100 seconds showed acid production after only 13 days' storage at 130° F. Similarly inoculated corn processed for 150 or 200 seconds did not produce acid after 4 months' storage at 130° F. These results indicated that on using this procedure a minimum process time falling between 100 and 150 seconds is required for destruction of NCA organism 1518.

Organoleptic evaluations made on the processed corn stored at room temperature are summarized in Table 3. An unlabeled control sample of frozen sweet corn was included in the judging each time. Scores for 6 judges for each sample were averaged, and the average scores were analyzed statistically.

If the organoleptic quality of the frozen control is considered to remain constant during the 4-month storage period, it may be used to relate the organoleptic rating after storage with the initial rating for each criterion and thereby correct for memory lapses by the judges. The ratio of the average organoleptic rating for each process to the average rating given the frozen control for the same storage time is given in the second half of Table 3. This will aid in following the comparisons to be made.

As shown in Table 3, there was no significant dif-

TABLE 2

Effect of process time, inoculation with NCA 1518, and storage time on the vacuum and acid production in processed cans of cut sweet corn incubated at 130° F.

Process time	F_o	Inoculation	Storage time	Vacuum (inches)	Acid production
75 seconds	11.6	5,000,000 spores/can	13 days	16	+
75 seconds		5,000,000 spores/can	13 days	15	+
75 seconds		5,000,000 spores/can	4 months	17	+
75 seconds		5,000,000 spores/can	4 months	17	+
75 seconds		none	13 days	20	−
75 seconds		none	4 months	15	−
100 seconds	16.4	5,000,000 spores/can	13 days	16	+
100 seconds		5,000,000 spores/can	13 days	15	+
100 seconds		5,000,000 spores/can	4 months	12	+
100 seconds		5,000,000 spores/can	4 months	17	+
100 seconds		none	13 days	16	−
100 seconds		none	4 months	17	−
150 seconds	26.1	5,000,000 spores/can	13 days	22	−
150 seconds		5,000,000 spores/can	13 days	22	−
150 seconds		5,000,000 spores/can	4 months	17	−
150 seconds		5,000,000 spores/can	4 months	8	−
150 seconds		none	13 days	17	−
150 seconds		none	4 months	5	−
200 seconds	35.8	5,000,000 spores/can	13 days	21	−
200 seconds		5,000,000 spores/can	13 days	22	−
200 seconds		5,000,000 spores/can	4 months	6	−
200 seconds		5,000,000 spores/can	4 months	13	−
200 seconds		none	13 days	24	−
200 seconds		none	4 months	17	−

TABLE 3
Organoleptic evaluation of processed cut corn initially and after four months' storage at room temperature as compared to a frozen control

Process time	Flavor		Color		Texture		Off-Flavor	
	Initial	4 months	Initial	4 months	Initial	4 months	Initial	4 months
A. Average Organoleptic Ratings								
75 sec.	8.2	6.8	8.8	8.8	8.2	7.8	8.8	8.4
100 sec.	7.9	6.9	8.2	9.5	7.9	8.7	8.8	7.6
150 sec.	7.9	6.7	8.8	9.6	7.8	8.8	8.4	7.0
200 sec.	8.0	6.9	8.9	9.3	8.1	8.6	8.5	7.3
Frozen control	7.5	8.3	8.1	9.0	7.9	8.3	7.7	9.1
B. Ratio of Organoleptic Rating to that for Frozen Control								
75 sec.	1.05	.82	1.04	.98	1.02	.94	1.07	.92
100 sec.	1.03	.83	1.00	1.03	1.00	1.02	1.07	.83
150 sec.	1.03	.81	1.04	1.03	1.00	1.03	1.05	.77
200 sec.	1.03	.83	1.05	1.02	1.01	1.02	1.05	.80
Frozen control	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

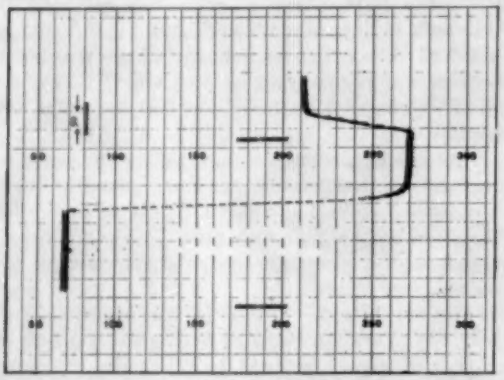

Figure 4. Graph showing heat penetration into corn kernel during processing of No. 2 can at 269° F. by direct injection of steam.

ference initially between heat processed samples and frozen control for each of the organoleptic criteria. Thus, one day after processing, heat sterilized samples were at least equal in quality to the frozen sweet corn. The same comparison made after 4 months' storage leads to the same conclusion for color and texture but not for flavor and off flavor. After this storage time at room temperature the heat-processed samples were inferior in flavor and off flavor to the frozen control (significant at the 1% level). Furthermore, when the frozen control was excluded, statistical analysis showed a highly significant effect of storage on the flavor and off-flavor characteristics of the processed samples but not on texture and color.

Decrease in flavor ratings upon storage was probably the result of the same mechanism which caused the development of the off-flavor. Several testers described the off-flavor as typical of enzymatically catalyzed reactions in sweet corn, and enzymes are the most likely cause of this quality deterioration. Evidently the thermal process at even the longest time was not sufficient to destroy the enzymes as shown by Farkas *et al. (4)* or there occurred an enzyme regeneration of the type reported by Guyer and Holmquist *(5)*. In the procedure followed for this study, the corn was not blanched and entered the sterilization chamber at a temperature below 70° F. In order to inactivate enzymes it would be necessary to preblanch the corn or use a longer process time.

SUMMARY AND CONCLUSIONS

A high temperature-short time procedure for sterilization of vegetables has been developed. By this procedure 5,000,000 spores of NCA organism 1518 per No. 2 can of whole kernel sweet corn can be destroyed within 150 seconds.

Data describing the penetration of heat have been presented. They showed that there is no "slowest heating point" in the can using this procedure.

Samples graded organoleptically one day after processing showed no important difference from the frozen control. After four months' storage at room temperature, samples still rated high in color and texture but had developed an off-flavor described as "enzyme-induced". Results indicated that enzymes were not completely inactivated by this procedure.

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A Study of Canned Syrup-Pack Whole Carrots[a]

(Manuscript received November 8, 1956)

W. D. Powrie and E. A. Asselbergs
Canada Department of Agriculture, Ottawa

FOR MANY YEARS, North American housewives have prepared candied sweet potatoes and carrots to serve as garnishes for roasts and steaks. Recently, canned whole sweet potatoes, packed in medium and heavy syrup, have been readily accepted by consumers as a time-saving, convenient product *(1, 5)*. Conceivably, canned syrup-pack carrots would likewise become popular if a high quality product could be developed. Up to the present time, no information has been reported on the canning and acceptability of syrup-pack carrots. This study was designed to investigate the effect of sucrose concentration in the in-going syrup on the quality characteristics of canned whole carrots.

EXPERIMENTAL

The carrot varieties, Amsterdam and Gold Spike, used in this study, were grown at the Horticultural Organic Substation, Ste. Clothilde de Chateauguay, Quebec, during the 1955 season. After being harvested, the carrots were stored at approximately 33° F. (0.6° C.) for one month. Carrots, selected for uniformity in size and shape, were abrasion peeled, trimmed, washed, placed into No. 2 carrot-enamel cans (327 g. per can) and covered with liquid at 200° F. Each of the following liquids was added to 5 cans of carrots; water, 10, 15, 20, 25, 30, 35, 40, 45 and 50% sucrose syrups. The cans were exhausted for 3 minutes, processed at 250° F. (121.1° C.) for 25 minutes and stored at 75-80° F. (23.9-26.6° C.) for 3 months.

Drained weights were recorded after the carrots were drained for one minute on a 2-mesh wire screen. The percent soluble solids of the cutout syrups were determined with an Abbé refractometer. The pH values of the cutout syrups were measured with a Beckman Model G pH meter.

Firmness of the carrots was determined by a method similar to the one described by Whittenberger *(6)* for measuring the firmness of cooked apple tissues. A cylinder, having approximately equal portions of phloem and xylem, and a diameter of 15 mm., was obtained from each carrot by pushing a sharp cork borer downward from the crown and parallel to the side of the carrot. From each cylinder, two cylindral samples, each 11.8 mm. in length, were cut. A Delaware jelly-strength tester was employed to compress each cylindrical sample. A cylindrical sample was placed on the ground glass surface of a petri dish which was held on the adjustable platform of the jelly-strength tester. The plunger was lowered to the surface of the carrot sample and the plunger height was read. The plunger was then allowed to rest on the cylindral sample for 8 to 10 seconds and air pressure was applied to the plunger at a constant rate until a pressure of 16 inches of carbon tetrachloride was attained in 30 seconds. At this point the plunger height was again read. Two compression readings for each carrot were obtained and the average percent compression for each sucrose treatment of canned Amsterdam and Gold Spike carrots was reported.

For both Amsterdam and Gold Spike carrots, the phloems of the carrots from each sucrose treatment were combined and puréed. The color of each puree was measured with a Hunter Color and Color-Difference Meter which was standardized with a color plate having values of $R_4 = 29.1$, $a = -3.3$ and $b = +35.0$.

Puréed whole carrot samples of the 0, 20, 25, 30, 35 and 40% sucrose syrup packs were evaluated by 4 taste panel members at 4 sessions for typical carrot flavor and bitter-sour taste. The carrots packed in 10, 15, 45 and 50% sucrose syrup were considered in preliminary taste tests to be unacceptable due to either excessive bitter-sour flavor or sweetness. Carrots puréed with no added sucrose, although excessively bitter-sour were included in the taste test to serve as control samples. At each session, randomized carrot samples at room temperature were numerically scored from 1 to 3 for carrot flavor with 1, 2 and 3 as slight, moderate and intense, respectively, and from 0 to 3 for bitterness with 0, 1, 2 and 3 as none, slight, moderate and intense, respectively. The judges wore dark-colored glasses at each of the 4 taste sessions.

RESULTS AND DISCUSSION

Average soluble solids in the cutout syrups of the canned carrots are reported in Table 1. Up to 40% sucrose concentration, the soluble solids of the syrups of Amsterdam were somewhat higher than those of Gold Spike at the same sucrose levels. The pH ranges of 5.06-5.22 and 5.04-5.23 were similar for the cutout syrups of Amsterdam and Gold Spike carrots, respectively. No significant relationship existed between the pH values and sucrose concentrations of the syrups.

Data in Table 1 indicate that the sucrose concentration in the syrup did not have an appreciable effect on the drained weight of the canned carrots. Lowest drained weight for each variety was obtained with water as the in-going liquid. At each level of sucrose concentration, the drained weight of Amsterdam carrots was slightly higher than that of Gold Spike.

Regardless of treatment, the carrots upon draining were whole and no degradation of the flesh was visually apparent. In order to measure quantitatively the firmness of the carrot flesh, an objective method, utilizing the Delaware jelly-strength tester, was employed. As shown in Table 1, the average percent compression of

TABLE 1

Effect of sucrose concentration in the in-going syrup on the quality characteristics of the canned whole carrots

Carrot variety	Sucrose concentration in in-going syrup	Soluble solids of cutout syrup[1]	Drained weight of carrots[1]	Compression[1]	
	%	%	g.	%	*Standard deviation*
Amsterdam	0	6.0	329	49	20
	10	10.1	330	51	14
	15	12.8	333	39	14
	20	15.1	335	37	14
	25	17.3	333	24	17
	30	20.3	333	21	15
	35	22.5	334	14	3
	40	24.4	333	17	6
	45	28.0	337	15	3
	50	29.6	333	15	4
Gold Spike	0	5.2	316	43	21
	10	9.5	322	39	22
	15	11.7	320	27	20
	20	14.0	321	22	17
	25	16.4	326	26	22
	30	19.1	326	22	16
	35	21.7	328	16	3
	40	24.2	326	14	5
	45	28.2	328	13	6
	50	30.5	327	15	4

[1] Average value for 5 cans of carrots, except that for the 0% and 25% sucrose concentrations of the variety Amsterdam only 3 and 4 cans respectively were examined.

[a] Contribution No. 884 from the Horticulture Division, Experimental Farms Service.

the flesh of both varieties decreased with an increase of sucrose concentration in the in-going syrup up to 35% sucrose level; hereafter, compression values remained fairly constant. With sucrose levels from 0% to 30%, the standard deviations of the compression values were high. However, the variation of readings of carrots treated with sucrose concentrations of 35% and above was decidedly lower, with standard deviations ranging from 3 to 6. Perhaps the variation of compression readings of carrots with a definite treatment may be attributed to the variation in the susceptibility of intercellular breakdown. Presumably, high concentrations of sucrose are capable of reducing the variation of readings by uniformly inhibiting the breakdown of intercellular cementing material. Obviously, reduction of variation of canned carrot firmness is important from a quality control standpoint.

In general, with an increase of sucrose concentration in the in-going syrup the orange color of the phloem became visually deeper while the color change of the xylem was not apparent. In a few cases phloems were rated equal in color although treatments were different. In order to measure objectively the color differences of puréed phloems the Hunter Color and Color-Difference Meter was used. For both Amsterdam and Gold Spike phloems, the tendency for reflectance (R_d) and yellowness ($+b$) to decrease and redness ($+a$) to increase slightly with an increase in the sucrose level is shown in Table 2. Perhaps these color changes may be attributed in part to the physical changes in the carrot tissue.

Studies have shown that sucrose is capable of improving the flavor of some foods. The actual fruit flavor of canned and frozen peaches *(3, 4)*, as well as frozen raspberries and blackberries *(2)* can be enhanced by the addition of sucrose. It was reasoned that perhaps the typical carrot flavor would be enhanced and the undesirable bitter-sour taste would be reduced by the presence of a definite amount of sucrose. The average taste-test scores (Table 3) show that Amsterdam and Gold Spike carrots, treated with 25% and 30% sucrose syrup, respectively, had a significantly high degree of carrot flavor. Both varieties of carrots with no sucrose treatment were not only scored lowest for carrot flavor but also possessed the greatest amount of bitter-sour taste. Although a slight bitter-sour taste was detected in carrots treated with 20% sucrose syrup, this undesirable taste was masked completely in packs with higher sucrose concentrations.

TABLE 2

The effect of sucrose concentration in the in-going syrup on the color of the canned whole carrots

Sucrose concentration in in-going syrup	Amsterdam			Gold Spike		
	R_d	$+a$	$+b$	R_d	$+a$	$+b$
0	15.5	26.9	28.2	15.7	29.0	28.8
10	14.2	26.4	27.3	14.4	29.7	28.2
15	14.0	27.4	26.7	14.1	29.9	28.1
20	13.3	28.7	26.7	13.9	29.9	27.7
25	12.9	28.4	26.1	13.2	30.8	27.0
30	12.4	29.0	26.0	13.1	29.3	27.2
35	12.0	29.0	26.1	12.5	30.5	26.8
40	11.7	28.2	25.5	12.0	30.4	26.0
45	11.8	29.2	25.7	11.6	30.7	25.6
50	11.2	30.0	25.4	10.1	30.7	25.2

TABLE 3

Effect of sucrose concentration for the in-going syrup on the flavor of the canned carrots

Carrot variety	Sucrose concentration in the in-going syrup	Average taste-test scores for carrot flavor
	%	
Amsterdam	0	1.00
	20	1.75
	25	2.88
	30	1.88
	35	2.00
	40	2.06
		L.S.D. (0.05) = 0.55
Gold Spike	0	1.00
	20	1.69
	25	2.00
	30	2.87
	35	1.94
	40	1.88
		L.S.D. (0.05) = 0.29

Panel members, considering color, typical carrot flavor, and sweetness, selected Amsterdam and Gold Spike with 25 and 30%, respectively, as the most acceptable products. The texture and firmness of whole carrots packed in 20% and higher sucrose syrups were rated as satisfactory. In order to assess the product from a consumer's viewpoint, both varieties of carrots treated with 25 and 30% sucrose syrups were fried in butter, baked in an oven and heated in their syrups before being submitted to the panel. Regardless of the heating method Amsterdam and Gold Spike carrots, packed in 25 and 30% sucrose syrup, respectively, were preferred. Since the heated carrots had excellent carrot flavor, uniform sweetness, desirable firmness, and rich orange color, it is assumed that the housewife would readily accept them as a time-saving, convenient, high-quality product. Further, candied carrots prepared in the home are not as desirable as the canned product since the sugar is not evenly distributed throughout the flesh, a bitter-sour taste is frequently detected, and the delicate carrot flavor is sometimes not apparent.

SUMMARY

Effect of sucrose concentration in the in-going syrup on the quality characteristics of canned whole Amsterdam and Gold Spike carrots was studied. Differences in the drained weights of carrots due to sucrose treatment were small and from a practical standpoint were not important. Firmness of the carrot flesh tended to increase as the sucrose concentration increased to the 35% sucrose level. As the amount of sucrose in the in-going syrup was increased, the reflectance and yellowness of the phloems tended to decrease, while the redness increased slightly. At 25 and 30% sucrose levels, Amsterdam and Gold Spike carrots, respectively, possessed superior typical carrot flavor and no bitter-sour taste.

Results of this study indicate that high-quality canned syrup-pack whole carrots can be produced.

Acknowledgments

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Factors Affecting Quality of Prepackaged Meat. I. Physical and Organoleptic Tests. A. General Introduction. B. Loss of Weight and Study of Texture[a, b]

C. Olin Ball, Warren E. Clauss, and Elizabeth F. Stier
Rutgers University, New Brunswick, N. J.

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A study of prepackaged fresh and cured meat extending through a period of five years, starting in 1949, was conducted by the Departments of Food Technology and Animal Husbandry of Rutgers University. The investigation was divided into four divisions, classified as follows:

1. **Physical and organoleptic studies.**
2. **Objective color studies.**
3. **Chemical studies related to organoleptic acceptance aside from color.**
4. **Microbiological studies.**

The report on Part 1 is divided into three sections, of which this paper constitutes the first two, viz., IA, General Introduction and IB, Loss of Weight and Study of Texture. Section IC, Organoleptic and Miscellaneous Characteristics of Product, will appear in the next installment.

PREPACKAGING MEAT FOR RETAIL DISTRIBUTION had its origin only a few years ago. During this comparatively short time, the development has been rapidly extended until thousands of supermarkets and other retail food stores now offer prepackaged meats to the American consumer.

Food Facts, distributed in 1953 by The Nicholas J. Janson Company, Inc., of Cincinnati, Ohio, states that "according to the *Nargus Bulletin*, official publication of the National Association of Retail Grocers, slightly more than half of the Nargus members, 50.3%, are converting at least partially to self-service in their meat departments. A percentage breakdown of the meat retailing operation of Nargus members showed that 12.5% have meat departments completely self-service; 37.8% have meat departments that are semi-self-service; and 49.7% have meat markets operated on a service basis. Meat departments do a larger share of the store's dollar volume when operated on a self-service, or even a semi-self-service basis, the survey reveals." Since 1953, the rate of increase in volume of self-service marketing of meat has become progressively greater.

The rapid growth of this method of retailing fresh meat has been due to a remarkable acceptance of the idea by consumers. From a merchandising standpoint, however, comparatively little progress has been made toward the solution of the major problems which manifested themselves at the beginning of the prepackaging era.

The problem. Average display life of prepackaged fresh meat is but little longer than 48 hours. Seldom is this product satisfactory in appearance after having been displayed for as long as 72 hours. Under past and present practice, the deterioration which limits the marketability of prepackaged meat is that which first affects appearance and later affects flavor and odor. To lengthen the period of marketability, therefore, the first requirement is to prolong the retention of satisfactory appearance, primarily color, and then to postpone flavor and odor deterioration. This paper is the first of a series reporting a project designed to achieve this desirable result.

A. GENERAL INTRODUCTION

Objective of the project was to select or to develop the combination of packaging materials, packaging conditions, and storage conditions which are commercially applicable and which will best inhibit quality degradation of prepackaged meats. The problem was attacked by determining the nature of some chemical, physical, and microbiological changes that accompanied quality degradation in meats, which had been both packaged and stored under various conditions in several types of packaging materials. During a period of 4 years, 40 runs or experiments were conducted. The runs were designated by letter and ran from A to NN. There was also a series of 6 runs made in the study of the effects

[a] A report of work conducted by contract with the Bureau of Animal Industry, U. S. Department of Agriculture, with funds provided under the Research and Marketing Act.

[b] A paper of the Journal Series, N. J. Agricultural Experiment Station, Rutgers University, the State University of New Jersey, Departments of Food Technology and Animal Husbandry, New Brunswick, N. J.

of gases on color of meat, which are given numerical designations 1 to 6 inclusive. Each experiment, except Runs LL, MM and NN, and the 6 numerical runs, included raising of animals, slaughtering, and butchering. This was followed by preparation and packaging of the samples and then by storage of the samples for an overall period of from 7 to 33 days. During an experiment, 5 or 6 periodic removals, following storage periods of from one day to the maximum number of days used for the run, were made. Hunter Color Meter readings, organoleptic panel tests, chemical tests, and microbiological tests were performed on the samples taken out of storage on these 5 or 6 removal days.

EXPERIMENTAL APPROACH AND METHODS

Source and preparation of meat. Except where noted to the contrary, meat was obtained from steers, lambs, and hogs raised by the Animal Husbandry Department. In advance of each run, plans were made concerning the species and number of animals needed so that ample time was allowed for raising the animals under specified conditions. Animals were slaughtered and most of the carcasses hung in the slaughter house cooler 5 days prior to the initial storage day. (In the early part of the investigation a few steer carcasses hung for 7 days). Average temperature in the cooler was 34° F. On the day before the samples were to be packaged, the wholesale cuts to be used were removed from the carcasses and placed in a walk-in refrigerator at 45° F.

Preparation of meat for packaging. Prior to packaging day, paper on which the meat was to be divided into samples was heated in saturated steam at 250° F. for 15 minutes. All utensils to be used in preparing the samples, such as knives, pans, churns, and grinder were washed with soap and water, rinsed with a 1% sodium hypochlorite solution, rinsed with water, rinsed with a 5% sulfite solution, rinsed again with water, and dried.

On the initial storage day, meat was removed from the walk-in refrigerator and placed on the paper on the cutting table. Procedure used to obtain ground meat samples was to bone and cut the meat into pieces small enough to feed into the grinder. A Hobart model A-200 grinder-mixer with a grinding plate having 3/16 inch holes was used. For samples designated as lean samples, as much fat as possible was removed and the lean meat was ground twice. For samples designated as fat samples, in most runs approximately equal amounts of fat and lean were ground together twice. In some runs, samples designated as fat samples contained other proportions of fat and lean. The ground meat was mixed for 2 minutes and then put into the refrigerator until time for packaging. Treatment with bacterial culture, antioxidant, or antibiotic was carried out while mixing and, in such treatment, time of mixing was increased to 5 minutes.

In some runs rectilinear cuts of meat, approximately 3 x 2 x ½ in., rather than ground meat, were used. Lean samples were cut from meat from which fat had been removed. Fat samples were cut so that a portion of the surface was composed of fat, the remainder being lean. Prior to packaging, cut samples were put into a churn, which was then rotated to distribute the microorganisms naturally present on the meat to approximately the same concentration on all of the meat surfaces. Distribution of added antioxidants or bacterial cultures to cut samples also was accomplished by churning. Meat was then stored in the refrigerator and removed as needed for packaging.

In Runs A through F and W through EE, cut samples were used. Ground meat was used in Runs G through V, both lean and fat samples being prepared. The fat samples consisted of approximately 50% lean and 50% fat in these runs, whereas other proportions of lean and fat were used in later runs. Both cut and ground samples were used in Runs FF through LL. Ground fat samples were used in Runs MM and NN.

During preparation of samples for Run W, a sufficient amount of the same lot of meat was frozen at —9° to —15° F. for use in Run X, which was started 21 days later. Similarly, at the beginning of Run Y, half of the meat was set aside and frozen for use in Run Z, started 26 days later. This was repeated for Runs AA and BB. Thawing of meat was accomplished by holding at room temperature 24 hours and then at 34° F. for 24 hours.

Special treatment of samples before packaging. In Run S, a portion of ground meat for "fat" samples was inoculated with *Achromobacter* before packaging.

In Run T, 4 portions of ground meat, two designated as "lean" samples and two as "fat" samples were mixed with 2 levels of ascorbic acid, 0.1% in one lean and one fat portion and 0.25% in the other 2 portions.

In Run U, 2 portions of ground meat, one portion "lean" and the other portion "fat", were mixed with 0.1% ascorbic acid by weight.

In Run V, the same procedure as in Run U was used except that antioxidant N.D.G.A. was substituted for ascorbic acid.

In later runs, treatment of samples with ascorbic acid included the additional levels of 0.05% and 0.5%.

In Run X, a group of lean cut samples was prepared so that half of each side of each sample was covered with fat during storage.

Packaging procedure. For samples used in most of the organoleptic, microbiological, chemical, and color tests, a standard packaging procedure was followed. Samples were packaged as quickly as possible. Most of the can samples were sealed in the can closing machine using a vcauum of 27 in., as read on the machine vacuum gauge. Measurements of vacuum in the cans after sealing showed maximum values of 25.5 inches. In Runs R and S, a group of "canned" samples was sealed in the can closing machine under 15 inches of vacuum. Most of the film packages were sealed on a film heat sealing machine at 27 inches of vacuum or higher, with the exceptions mentioned below.

The following packaging materials, given with their code designations, were used in the project:

Code number		Packaging material
2		can
3		unpackaged
4a		vinylidene copolymer (Cry-O-Vac)
6		MSAT86 cellophane, coated both sides
6a		MSAT80 cellophane, coated side inside
6d	(1)	MSAT80 cellophane, coated side outside
6w	(1)	MSAT80 cellophane, coated side outside (wrapped)
8	(2)	cellulose acetate P-912
10	(1)	polyethylene
15		cellophane-pliofilm laminate, pliofilm inside
16		cellophane-polyethylene laminate, polyethylene inside
17		cellulose acetate-pliofilm laminate, pliofilm inside
20		trithene (wrapped)

(1) "Hand" made in the laboratory; (2) "hand" made by Celanese Corp.; all other film packages except No. 20 were "factory" made by Standard Packaging Corp.

The containers were 5 by 6 in. pouches, made from the above materials. All pouches were sealed under 27 to 29 inches of vacuum, except package type 8 (cellulose acetate), sealed with a solvent at atmospheric pressure; film 15 in one run, sealed at atmospheric pressure; package type 6w, taped shut at atmospheric pressure; and package type 20, devoided of air as much as possible by hand pressure, folded over at the open end, and taped shut.

Desiccators used to store samples were sealed under different pressures, varying from atmospheric pressure to 28 inches of vacuum.

When package type 2 (can) is mentioned in this report without qualification as to the conditions of packaging, it is to be understood that it was sealed under 26 to 28 inches of vacuum. Whenever package types 4a, 6, 6a, 6d, 10, 15, 16, or 17 are mentioned without qualification as to the conditions of packaging, it is to be understood that they were sealed under 27 to 29 inches

of vacuum. Package types 6w, 8, and 20 are understood always to have been closed in air at atmospheric pressure.

In Runs W and X, samples in unsealed 15 pouches were placed, open-end-up, in desiccators under reduced pressure. Three pouches containing the samples were removed from the desiccators at various time intervals, sealed under 27 inches of vacuum, placed in the storage cabinet, and then examined 6 days later.

Physical properties of films. Table 1 contains information taken from the literature and other sources and does not necessarily represent the exact physical properties of the films used in this project. It gives an approximation of the comparative physical properties of some of the films used.

Table 2 shows results of physical tests conducted by the Visking Corporation [*] on samples of the actual film materials used in the studies reported herein. The method used was Visking's own modified Todd method on dry film at 77° F. The figures shown represent values from single determinations. No claim can be made that they broadly represent the type of film indicated.

It is emphasized that these permeabilities were measured on the films in the dry state, while the experiments of the project were conducted with the inside of the films wet, from contact with the meat, and the outside dry.

Plain regenerated cellulose, the basic non-moisture proof uncoated cellophane, is highly impermeable to fixed gases in the dry state, but is quite permeable in the wet. If this material is coated with a moisture proof lacquer on one side, and the coated side placed next to the meat, as is the case with package 6a, the lacquer will protect the cellophane from becoming wet, and the permeability will be relatively unchanged. When the non-coated side is placed next to the meat, however, as with packages 6d and 6w, the cellophane becomes wet and there is a resultant increase in fixed gas permeability of the composite material. Thus, under the conditions used in the project, the O_2 permeability of package 6d is probably considerably greater than that of 6a, although the only difference between the 2 packages was that 6a was made with the coated side in and 6d with the coated side out.

TABLE 1

Comparative physical properties of some of the films used in this project

	Polythene or Reynolon 1000 Polyethylene Visqueen Comparable to Package 10	Vinylidene—Type Copolymer Comparable to Package 4a	Cellulose Acetate Comparable to Package 8	Moist. Resis. Cellophane Regenerated Cellulose Comparable to Package 6	Laminated Pliofilm-Cellophane Comparable to Package 15
Thickness—Mils.	1.0	1.0	1.0	0.9	2.8
WVTR—100° F. Flat Gms./100 in.²/24 hrs.	0.9—1.2	0.35	30	0.3 0.8	0.85
WVTR—0° F. Flat	0.02	0.05 (+5° F.)			0.03
Transmission O_2 cc./100 in.²/24 hrs.[1]	226	0.45	148	.065	.019
Transmission CO_2	905	0.32	1100	1.29	
Organic Vapor Permeability	High			Low	Low

[1] Corrected to 760 mm. Hg. difference in partial pressure of test gas across test sheet.

STORAGE CONDITIONS

After packaging, the samples were stored in a refrigerated cabinet until removal for examination. Temperatures were measured in all parts of the storage cabinet during every run. The left end of the cabinet was always from 1 to 2 degrees lower in temperature than the right end. Also, there was a fluctuation of temperature with time. Mean temperatures of the cabinet at the lower and upper extremities of the ranges of the fluctuation with time were as follows:

(a) in Runs A through Q, 32° F. to 38° F.

(b) in Runs R through NN, 38° F. to 44° F.

Samples were placed in the cabinet so that each group of replicates was subjected to the same temperature variations rather than having replicates of one collocation at one average temperature and replicates of another collocation at another average temperature. In the latter case, it would have been impossible to tell whether quality differences were due to the intentionally varied factors or to the unavoidable differences in temperature. Unless otherwise stated, all results presented in this report were obtained with storage temperatures of from 32° F. to 44° F. For the samples of certain

[*] Communication, Aug. 20, 1953, from C. J. B. Thor, Manager of Central Laboratories and Food and Packaging Research, the Visking Corporation, 6733 West 65th Street, Chicago 38, Illinois.

TABLE 2

Results of tests on the film materials used in this project

	Vinylidene Type—Copolymer Package 4a	MSAT86 Cellophane Package 6	MSAT80 Cellophane Packages 6a, 6d and 6w	Cellulose Acetate Package 8	Polyethylene Package 10	Flex Vac 182 Cellophane-Pliofilm Laminate Package 15	Flex Vac 190 Cellophane-Polyethylene Laminate Package 16	Flex Vac 124 Cellulose Acetate-Pliofilm Laminate Package 17
Thickness—mils.	1.27	1.16	1.05	1.34	2.29	2.74	3.29	2.43
Transmission cc./100 in.²/24 hrs. O_2	.80	No transmission in 24 hrs.	No transmission in 24 hrs.	89.67	249.14	No transmission in 24 hrs.	No transmission in 24 hrs.	18.17
CO_2	19.15	13.97	11.64	838.9	1179.94	9.67	16.6	84.41
N_2	No transmission in 24 hrs.	No transmission in 24 hrs.	No transmission in 24 hrs.	17.84	61.03	No transmission in 24 hrs.	No transmission in 24 hrs.	2.78
Transmission cc./100 in.²/24 hrs./mil. O_2	1.02			120.16	570.53			44.15
CO_2	24.11	16.21	12.22	1124.13	2701.83	26.50	54.61	205.12
N_2				23.90	139.76			6.76

TABLE 3
Description of Runs A to NN

Run	Slaughter date	Specie	Diet	Holding period (days)	Type samples	Parts of carcass	Special treatment	Package types
A	2/8/50	Hog	Grain	5	Cut	Loins		2, 3, 6a
B	3/16/50	Hog	Grain	5	Cut	Loins		2, 3, 15
C	4/13/50	Hog	Grain	5	Cut	Loins and Legs		2, 3, 6a
D	5/19/50	Hog	Garbage	5	Cut	Loins		2, 3, 6a, 15
E	6/23/50	Hog	Garbage	5	Cut	Fresh Hams		2, 3, 6a, 15, 16
F	7/25/50	Steer	Grain	7	Cut	Top and Bottom Round		2, 3, 6a, 15
G	9/5/50	Steer	Grass and Grain	7	Ground	Top and Bottom Round		2, 3, 15
H	10/9/50	Steer	Grass	5	Ground	Top and Bottom Round		2, 6a, 15
I	11/8/50	Lamb	Grass and Grain	5	Ground	Shoulder, Back, Loin		2, 15, 17
J	1/10/51	Steer	Grass and Grain	5	Ground	Top and Bottom Round		2, 15, 17
K	2/4/51	Steer	Grass and Grain	5	Ground	Top and Bottom Round		2, 16, 17
L	3/28/51	Hog	Grain	5	Ground	Fresh Hams		2, 15, 16
M	4/25/51	Hog	Grain	5	Ground	Fresh Hams		2, 15, 17
N	6/4/51	Lamb	Grain	5	Ground	Shoulder, Back, Leg	Room Temperature	2, 6a, 15
O	7/6/51	Steer	Grain	5	Ground	Round, Sirloin	Room Temperature	2, 4a, 6a, 8, 15
P	8/8/51	Lamb	Grain	5	Ground	Shoulder, Leg	Room Temperature Inoc.-Achrom.	2, 6a, 15
Q	9/7/51	Lamb	Grain	5	Ground	Shoulder, Leg	Room Temperature	2, 6a, 6d
R	10/3/51	Lamb	Grain	5	Ground	Shoulder, Leg	Room Temperature 15" Vacuum	2, 6d, 15
S	11/1/51	Hog	Grain	5	Ground	Fresh Hams	Inoc.-Achrom. 15" Vacuum	2, 6d, 15
T	11/29/51	Lamb	Grain	5	Ground	Shoulder, Leg	Ascorbic Acid Antibiotics	2, 10, 15
U	12/28/51	Lamb	Grain	5	Ground	Shoulder, Leg	Ascorbic Acid	2, 10, 15
V	1/16/52	Lamb	Grain	5	Ground	Entire	NDGA	2, 10, 15
W	2/13/52	Steer	Grain	5	Cut	Round		2, 15
X	2/13/52	Steer (frozen)	Grain	5	Cut	Round	(frozen for holding)	2, 15
Y	4/11/52	Hog	Grain	4	Cut	Fresh Hams	Light and dark	2, 15
Z	4/11/52	Hog (frozen)	Grain	4	Cut	Fresh Hams	Light and dark (frozen for holding)	2, 15
AA	5/28/52	Hog	Grain	5	Cut	Fresh Hams	Light and dark	2, 15
BB	5/28/52	Hog (frozen)	Grain	5	Cut	Fresh Hams	Light and dark (frozen for holding)	2, 15
CC	8/7/52	Steer	Grain	5	Cut	Round	Ascorbic Acid	2, 15
DD	9/5/52	Steer	Grain	5	Cut	Round	Ascorbic Acid	2, 15
EE	10/3/52	Steer	Grass	5	Cut	Round	Ascorbic acid and different pressures	2, 15, desicc.
FF	10/29/52	Hog	Grain	5	Cut and Ground	Fresh Hams and Shoulders	Pressure	2, desicc.
GG	11/12/52	Hog	Grain	5	Cut and Ground	Fresh Hams and Shoulders	Sealing and wrapping in 6d	2, 6d, 6w, desicc.
HH	12/10/52	Lamb	Grain	5	Cut and Ground	Legs, Shoulders	Sealing and wrapping in 6d, vacuum	2, 6d, 6w, desicc.
II	1/7/53	Lamb	Grain	6	Cut and Ground	Legs, Shoulders	Sealing and wrapping in 6d, oxygen pressure	2, 6d, 6w, 15, desicc.
JJ	1/28/53	Lamb	Grain	6	Cut and Ground	Whole Carcass	Sealing and wrapping in 6d, oxygen pressure	2, 6d, 6w, 15, desicc.
KK	2/25/53	Hog (fresh) and Cured Ham	Grain	6	Cut and Ground	Shoulders	Sealing and wrapping in 6d, vacuum	2, 6d, 6w, 15, desicc.
LL	3/24/53 (Packaging)	Market Beef and Cured Ham	....	....	Cut and Ground	....	Wrapping in Trithene	2, 15, 20
MM	March, 1953	Market Beef, Lamb, and Pork	....	....	Ground	....	Atmospheric Pressure and Vacuum	2
NN	April, 1953	Market Beef	....	....	Ground	....	Atmospheric Pressure and Vacuum	2

phases of the investigation or of certain parts of runs, special records of temperature were kept. In this report, therefore, various specific temperatures are named from time to time within the above mentioned range.

In Runs A through X, the samples were stored in the dark and in Runs Y through LL, the samples were stored in the light furnished by the fluorescent lamps in the cabinet. Where the effect of light vs. dark storage was to be studied in the latter series of runs, one set of samples was stored in the light and a duplicate set was stored in the dark. Intensity of the light to which the samples were subjected varied from 30 to 170 foot candles.

In each of several runs, a group of samples in cans sealed under 28 inches of vacuum was held at room temperature for 20 hours before storage at refrigerator temperature. In one run this holding time was 42 hours instead of 20.

Vacuum in all cans was measured by gauge. Vacuum retention of film packages was judged by viusal observa-

tions of the degree of separation of the film from the surfaces of the sample. (See definitions.)

A complete list of runs is given in Table 3 and a summary of the distribution of package types among the runs is shown in Table 4.

TABLE 4

Number of runs in which each type of package was used

Type package	2[1]	3	4a	6	6a	6d	6w	8	10	15	16	17	20
No. of Runs													
Cut Samples	22	6	0	5	0	5	5	0	0	17	0	0	1
Ground Samples	24	1	1	1	3	7	5	1	3	18	2	4	1
Total	40[2]	7	1	6	3	7[2]	5[2]	1	3	31[2]	2	4	1[2]

[1] Includes cans of 3 different sizes.

[2] Total number of runs is less than the sum of cut sample and ground sample runs because in 7 runs there were both cut and ground samples.

DEFINITIONS

Vacuum retention. Holding of original vacuum under which the package was sealed. With cans, this was measured by comparing readings of gauge on sealing machine with readings of gauge used to measure vacuum after storage. With films, this was estimated by comparing contour of the package in respect to contour of the surface of the sample after storage with that which was obtained just after sealing.

Degree separation. Extent to which a sealed package film has separated from the sample during storage, indicating amount of vacuum retention or loss.

Outside organoleptic color. Color of the outside, top, surface of the sample observed visually. This was graded on a 1-10 basis, 10 being best. Inside color was also graded, but is discussed only as a part of total organoleptic quality. Organoleptic color was graded by an organoleptic panel up until Run EE. From Run FF on, this grading was done only by the observer who opened the packages, because it was felt that the color of the samples changed during the time between the opening of the packages and the panel grading. Prior to Run FF, samples for organoleptic grading were usually held a few hours in the refrigerator, after the packages had been opened, before the organoleptic panel testing of color was carried out on them.

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Throughout the project the authors had the unstinted encouragement, help, and guidance of Dr. Walter A. Maclinn, Chairman of the Department of Food Technology.

The material presented herein was taken from reports of the above named workers, including the following theses:

Bressler, Lawrence—Color changes during storage of prepackaged cured ham sealed in cellophane-pliofilm laminate containers while surrounded by air at various pressures. (May 1954) (M.Sc.).

Broumand, Hormoz—The development of a spectrophotometric method for estimating of the pigmented compounds of meat. (July 1953) (Ph.D.).

Clauss, Warren—A study of subjectively measurable quality characteristics of meat, associated with the study of a definition of texture. (April 1954) (M.Sc.).

Halleck, Frank—A study of factors influencing bacterial growth in prepackaged meats and a correlation of bacterial counts with the color changes in the meat. (May 1952) (Ph.D.).

Miles, John J.—The changes in redness of prepackaged fresh meats as indicated by the Hunter Color and Color Difference Meter. September 1951) (M.Sc.).

Rikert, John A.—Color changes of fresh meats as influenced by some antioxidant, temperature, and atmospheric variations. (June 1952) (M.Sc.).

Rikert, John A.—The effect of some antioxidant, light, temperature, and atmospheric variations on the color of meat. (May 1954) (Ph.D.).

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B. Loss of Weight and Study of Texture

LOSS OF WEIGHT

WEIGHT LOSS WAS OBTAINED by comparison of initial weights of sample and package with post-storage weight of: (1) unopened package; (2) sample alone; (3) package plus drippings; (4) package without drippings (mechanically squeezed out with a straight edge); and (5) package washed and oven dried. On packaging day, the weight of each sample was obtained to get the net weight before storage. The sample was then packaged, sealed, and weighed for gross weight before storage and then placed in the refrigerated storage cabinet. As each sample was removed from storage, it was weighed before being opened to obtain the gross weight after storage. The container was then opened and the sample itself weighed to get the net weight after storage.

Difference between net weight loss and gross weight loss represented the residual material remaining in the container. The residual material represented the "drip loss" although it included the particles of meat adhering to the package.

Tables 1 and 2 present the approximate percentages of gross and net weight loss of lean and fat samples respectively after 3 weeks of storage for the 9 runs, G-N and P. Since removals were seldom made at precisely 21 days, the percentage weight loss for this storage period was estimated by interpolation of the values obtained at the removals before and after this time.

Some indication of the accuracy of these weighings can be obtained from the observed gross weight loss of the "canned" samples. It will be noticed that these samples indicated a loss as great as 0.9%. Actually, there should have been no gross weight loss in these samples, since the can is an impermeable container. Average error of these results is between 0.1 and 0.2%. No correction is made for such supposed error.

Average amount of residue remaining in the packages after removal of the samples was greater for lean samples than for fat samples. Average difference between percent net and percent gross weight loss, representing the residue in the packages, of the lean samples in package types 2, 15, 16 and 17 was between 1.1 and 1.8%. The residue in these package types containing fat samples was between 0.6 and 0.9%. Average difference between the percent net and percent gross

TABLE 1
Approximate percent gross and net weight loss of lean samples during three weeks of storage

Run	Meat used	Package type											
		2		3		6		6a		15		16		17	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
G	Beef	.3	2.3	26	26					1.4	2.6				
H	Beef	.1	2.6			3.0	3.8			.2	2.3				
J	Beef	0	1.0							.4	1.6			.2	1.3
K	Beef	—.1	.6									0	2.5	0	1.4
I	Lamb	0	2.1							.7	1.7			.2	1.1
N	Lamb	0	1.5					6.5	7.5	.6	2.2				
P	Lamb	.8	3.0					11	12	1.0	3.9				
L	Pork	0	1.2							.4	1.8	.3	1.5		
M	Pork	—.3	1.0							.5	1.6			0	1.0
Overall Average		.1	1.7	26	26	3.0	3.8	8.8	9.8	.7	2.2	.2	2.0	.1	1.2
Beef		.1	1.6	26	26	3.0	3.8			.5	1.6	0	2.5	.1	1.4
Lamb		.3	2.2					8.8	9.8	.8	2.6			.2	1.1
Pork		—.2	1.1							.5	1.7	.3	1.5	0	1.0

TABLE 2
Approximate percent gross and net weight loss of fat samples during three weeks of storage

Run	Meat used	Package type											
		2		3		6		6a		15		16		17	
		Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
G	Beef	.5	1.5	28	28					1.3	1.7				
H	Beef	.1	.9			3.2	4.0			.7	1.0				
J	Beef	0	1.3							.3	1.3			0	1.3
K	Beef	—.2	1.1									—.2	.6	.4	.9
I	Lamb	0	1.5							0	.9			.6	1.0
N	Lamb	0	1.0					9.0	10.0	.8	1.4				
P	Lamb	.9	1.0					10	11	1.4	2.0				
L	Pork	.2	1.0							.2	.5	.1	.8		
M	Pork	0	.5							.2	.9			.8	1.2
Overall Average		.2	1.1	28	28	3.2	4.0	9.5	10.5	.6	1.2	—.05	.7	.5	1.1
Beef		.1	1.2	28	28	3.2	4.0			.6	1.0	—.2	.6	.2	1.1
Lamb		.3	1.2					9.5	10.5	.7	1.4			.6	1.0
Pork		.1	.8							.2	.7	.1	.8	.8	1.2

weight loss of both the lean and fat samples in film 6 was 0.8 and of lean and fat samples in film 6a was 0.0.

Weight loss is evidence bearing on the preservative effect of the packages. A comparison of packages, based on data presented in Tables 1 and 2 is given in Table 3.

TABLE 3
Classification of packages in respect to prevention of net weight loss

Classification	Package type
Superior (1-2% Loss)	2, 15, 16, 17
Very good (3-4% Loss)	6
Fair (10% Loss)	6a
Poor (26-28% Loss, 10 days)	3 (unpackaged)

STUDY OF TEXTURE

TEXTURE IS COMMONLY USED as a criterion in evaluating meat for quality, but it has never been well defined. As part of this study of prepackaged meat, an attempt was made to find a definition which could be dependably utilized in grading meat for quality by the usual organoleptic procedures.

Definitions and precepts. Two tentative definitions were constructed, neither of which involved microscopic inspection of meat. The first, or "sight", definition read as follows: *Texture of meat is the macroscopic appearance of muscle tissue from the standpoint of smoothness or fineness of the grain. The "grain" is defined as the macroscopic appearance of cut surfaces of lean parts, which it is possible to describe as smooth, fine, rough, or coarse. Fineness is assumed to be dependent upon the size of the fiber bundles; the smaller the bundles under macroscopic examination, the finer the texture.* This definition was applied to both raw and cooked samples.

The second, or "feel", definition was worded: *Texture of cooked meat is the feel of smoothness or fineness of the muscle tissue in the mouth.*

"Sight" texture was studied by determining the relationship between the texture of meats and other organoleptic factors. A scoring scale of 1-10 was used with 10 indicating smooth texture and 1, a coarse or rough texture. Three types of texture were evaluated on each sample. Raw texture was estimated on a piece of meat by the panel by presenting the sample to the judges with a freshly cut side on the left. The panel was instructed to evaluate that surface.

Cooked surface texture and cooked internal texture were estimated on cooked samples. Cooked surface texture was evaluated on the surface which was uppermost during cooking. Cooked internal texture was estimated on a surface produced by the panel member cutting the sample immediately before evaluation.

"Feel" texture of cooked meat was evaluated in another part of the investigation using a numerical scale by a panel of two judges. The scale was 1-10 with 10 meaning *very fine* and 1, *very coarse.*

In a third part of the investigation the "feel" and "sight" definitions of texture were compared by an individual. The meats used in this study were purchased from local shops, as distinguished from that used in other sections of the study, which came from animals

that were raised for this project. Evaluations were again made on a 1-10 scale.

VALIDITY OF THE DEFINITION OF TEXTURE

When the data were evaluated on "feel" texture, there was a slightly consistent pattern of change with storage time in meat from grain fed hogs, which may have been coincidental; otherwise there was none. This sort of texture of meat apparently has too erratic a pattern of change to be used as an index of spoilage.

In a study of "sight" texture, correlation coefficients were calculated between texture and other quality characteristics. However, the correlation coefficients, whether direct or inverse, were poor. The correlations apparently prove nothing relative to the validity of the definition of texture.

Poor relationships were found also when the three types of sight texture were compared, i.e., texture of the raw sample, external texture of the cooked samples and internal texture of the cooked sample.

The results suggested that the characteristic of the raw product which was described by the definition remained about the same throughout the storage period. However, the characteristic of both the raw and cooked products, described by the definition, was not easily discernible by the judges, which necessitated guessing.

When the "sight" and "feel" definitions of texture were compared, the "sight" texture values gave a more consistent change with time in storage. However, even the "sight" definition merely indicated the apparent amount of moisture lost during storage and was not an index of spoilage of meat.

To be of value, a definition of texture should meet the following requirements:

1. The definition should describe an attribute that is different from any attribute which figures in the definition of another quality characteristic, with which texture is associated, such as tenderness or juiciness.
2. The definition should be consistent with the dictionary definition of the term.
3. The attribute described should be important in the use to which it is applied.
4. Examination results, based on the definition, should show a relationship to other attributes which, by the nature of their definitions, have a logical relationship to texture.

By definition, texture in this investigation was limited to the structure of meat. Therefore, texture, described as the macroscopic appearance of muscle tissue from the standpoint of smoothness or fineness of the grain, was a unique characteristic of meat and different from any other factor with which it was associated in use. The proposed definition could be used by the commercial meat grader or an organoleptic panel in evaluating a single characteristic of meat.

The "feel" definition also described a factor that was different from most other factors with which it was associated in use. The feel of smoothness on the tongue was not related to the means of determining any other attribute. However, it would bear a direct relationship to feel, defined as the presence or absence of sliminess of raw meat, provided the evidence of sliminess carried over to the cooked product. The "feel" definition may possess a defect in this regard.

Both the "sight" and "feel" definitions of texture were consistent with the dictionary definition of the term. That portion of the dictionary definition which refers to the sort of structure, interrelation of parts, or structural quality, applies most directly to texture as defined in this study. The appearance and feel of structure, used in these definitions, were limited to the fineness of the grain. The proposed definitions, therefore, met the second requirement.

The definition of texture, used either by an organoleptic panel or a commercial meat grader, should be important for the use to which it is applied. For the commercial meat grader this would mean that raw texture should be of value in predicting overall quality of meat. Unless relationships exist between texture, as evaluated by the meat grader, and overall quality, the factor would be of little importance.

From the association of meanings of texture, tenderness and juiciness, it would seem that a correlation among these factors is logical. Some correlation was found between texture and tenderness, but essentially none was found between texture and juiciness. Therefore, it might be said that the texture definitions studied meet the fourth requirement of a satisfactory definition to a highly limited extent.

Justification for an interest in texture of meat, as defined herein, appears to be indicated only because texture is thought to be related to the aesthetic appeal of the product to the consumer.

Certainly, the importance of macroscopic texture as a characteristic of meat does not seem to lie in its application as a spoilage index.

Effect of Temperature and Time of Scalding on the Tenderness of Breast Meat of Chicken[a]

W. G. Shannon,[b] W. W. Marion, and W. J. Stadelman
Purdue University, Lafayette, Indiana

(Manuscript received August 25, 1956)

TENDERNESS IN POULTRY MEAT can be attributed to several factors. Stewart *(6)* divides these into two classes, production and processing factors. The literature contains several reports of the effects of such production factors as age, breed, feed, and environment but processing factors have received very much less attention. In the case of red meat the relationship between tenderness and aging under refrigeration has been described by Deatherage and Harsham *(3)*. Wierbicki, Kunkle, Cahill and Deatherage *(7)* describe work on post-mortem changes likely to affect tenderness.

Stewart *(6)* stresses scalding, picking, cutting-up, aging and freezing as factors likely to have an effect on tenderness of poultry meat. Koonz, Darrow and Essary *(5)* report results of experiments in which the *pectoralis superficialis* and *pectoralis profundus* muscles were cut into and the tenderness pattern compared with that of controls. The treatment affected the tenderness pattern causing the cut muscles to be less tender than the controls even after 24 hours' storage.

A most important factor would appear to be aging. Carlin, Lowe and Stewart *(2)*, state that if birds are cooked too soon after slaughter the meat is stringy, rubbery, and tough, but if the carcass is allowed to age a few hours longer, the meat becomes tender. Two hours are suggested as necessary to see a lessening of toughness but that up to 10 hours may be required for maximum tenderness of white meat and 24 or more hours for thigh muscles. In older birds much longer periods may be necessary. The importance of aging was magnified by the development of freezing. Koonz, Darrow, and Essary *(5)* report that freezing, if too soon after slaughter, interferes with aging.

The purpose of this work was to measure the effects of various combinations of time and temperature of scalding chickens on the tenderness of the breast muscles.

EXPERIMENTAL

One-year-old White Leghorn fowl were used throughout these studies. Each hen was stunned, bled by slashing the throat, and left to bleed for 1 minute. The hens were individually scalded in a 60-gallon, hot-water vat with thermostatic controls to maintain the desired temperature to within 1° F. Hens were dipped by hand so that time of agitation in the scald water could be controlled to exact times. In order to cut off the residual effects of scald temperature during picking, each hen when withdrawn from the scalding water was immediately immersed in cold water.

Six levels of scald temperatures were used. These were 120°, 135°, 150°, 165°, 180°, and 195° F. (49°, 57°, 66°, 74°, 82°, and 91° C.). The 6 time-levels used were 5, 10, 20, 40, 80, and 160 seconds. Each temperature level was, of necessity, used in conjunction with a time level. Therefore, a 2^2 factorial design[c] was used *(4)*. There were 3 replications with 6 blocks in each, and each level of time and temperature was represented only once in each replication.

Mechanical picking was reported by Stewart *(6)* to affect tenderness. To eliminate this effect feathers were removed by hand. After picking, the birds were cooled in ice water for 2 hours. They were then eviscerated and stored for 24 hours in ice. On removal from ice each bird was drained and wrapped in aluminum foil. This package was placed in a small metal pan and cooked at 325° F. (163° C.) for 3 hours. A reel type oven with thermostatic temperature control was used. A complete block, 6 birds, was handled at one time.

After cooking, packages were opened and cooled for one hour in a refrigerated cabinet in which the temperature was approximately 45° F. (7° C.). After cooling, the entire flesh from each side of the breast bone was removed in one piece with a knife. Each side was then trimmed to fit the cell of a Kramer Shear Press. This meant cutting off equal portions from either end of the longitudinal axis of each side of breast. The cell measures approximately 2⅜ inches square. In no case was it necessary to trim the portions in a transverse direction. The trimmed portion was weighed. Then the force, in pounds, necessary to force the 10 blades of the shear press through the meat of each side of breast was recorded. The hydraulic ram which forces the blades downward was working in each case at 150 pounds. Working at this pressure the shear force reading for each portion of meat is, in fact, the resistance to travel offered by the meat. It is registered on a special dial. In order to eliminate thickness variations registered pressures were calculated on a gram weight basis.

Since separate readings were taken for left and right sides of each bird, the average of these two was taken as the tenderness value of each bird.

In replicate 3 subjective tests were made using a 5-member panel. The portions of meat that were trimmed off each end of the left and right sides of each bird were used for these tests. The portions were cut into pieces approximately one cubic centimeter, each panel member being given one of these squares from each bird. It was chewed until ready for swallowing and the number of "chews" taken as the measurement of tenderness. A single value for each bird was obtained by averaging the five values obtained.

RESULTS AND DISCUSSION

Tenderness of breast muscles of 108 Leghorn hens was determined. An analysis of these data, using procedures outlined by Kempthorne *(4)* for this experi-

[a] Journal paper No. 1016 of the Purdue University Agricultural Experiment Station. This work is from a thesis submitted to the faculty of Purdue University in partial fulfillment of the requirements for the Master of Science degree while the senior author was a W. K. Kellogg Foundation fellow during 1955-1956.

[b] Present address: Loughry Agricultural College, Cookstown, Co. Tyrone, Northern Ireland.

[c] The 2^2 factorial design used partially confounded time, temperature, and the time-temperature interaction with blocks. Confounding in this manner was considered necessary because the maximum number of chickens that could be handled during any one day was six. An intrablock subgroup was established in each replication on the basis of factors confounded. The remaining 5 blocks were then generated from each intrablock subgroup. Each replication contained all possible combinations of the 6 levels of time and temperature. As blocks were confounded with time, temperature and the time-temperature interaction, it was necessary to regard replications as being the true blocks in the analysis.

mental design, shows that the effect of time, temperature, and of the time-temperature interaction are all highly significant. The mean value over-three replications for each time and temperature combination is reported in Table 1. These values range from 5.70 pounds to 20.82 pounds. The least significant difference was calculated and found to be 3.35 at the 95% level of significance. All pressure readings greater than 9.05 pounds would therefore differ significantly from the lowest reading or 5.70 pounds.

Comparing average values for time it appears that times of 40 seconds or less have no significant effect on tenderness. The scald times of 80 and 160 seconds significantly decreased tenderness of breast meat of fowl at all temperatures except 120° F. (48.9° C.). The increasing of scald temperatures from 150° F. (65.6° C.) to 195° F. (90.6° C.) when compared over all times did not affect tenderness.

Combinations of high temperatures with high time cannot therefore be used, nor can long time be used even at the lower temperatures. High temperatures can be used provided the time is short.

A comparison of values obtained during the third application of the experiment by a "chewing" panel and the Kramer shear press is made in Table 2. The correlation between shear press readings and chewing was 0.86. Confidence limits of this correlation value calculated at the 95% level were 0.7385 to 0.9262. Cameron and Ryan *(1)* report a correlation of 0.975. The values listed under average number of chews suggest that for most of the samples tenderness values, using the tenderometer, of less than 8.5 were considered as tender by the panel.

During the experiment observations were made on ease of feather pulling at the various combinations of levels of time and temperature. The following times were considered minimal for the various temperatures to get an ease of feather removal comparable to commercial subscalding at 140° F. (60° C.) for 45 seconds:

135° F. (57.2° C.)	75 to 80 seconds
150° F. (65.6° C.)	25 seconds
165° F. (73.9° C.)	12 seconds
180° F. (82.2° C.)	5 seconds
195° F. (90.6° C.)	5 seconds

At 120° F. (48.9° C.) the maximum time of 160 seconds was not satisfactory and preliminary work prior to the experiment confirmed this since even 180 seconds at 120° F. (48.9° C.) was not sufficient. Eighty seconds at 135° F. (57.2° C.) was satisfactory for some birds but not for others. This could not, however, be increased without decreasing tenderness since the value for this combination is significantly different from the lowest obtained. Furthermore all of these times are only approximate since no really critical measurement of ease of picking was attempted.

TABLE 1

Average pressure readings on a Kramer Shear Press for each time and temperature combination over three replications calculated to a base of pounds pressure per gram of sample (sample size ranged from 30 to 50 grams)

Times (seconds)		5	10	20	40	80	160	Ave. for temp.
Temperatures								
° F.	° C.							
120	48.9	6.17	6.18	6.81	7.31	6.82	6.51	6.63
135	57.2	7.87	6.17	5.70	6.82	9.90	12.02	8.08
150	65.6	8.91	6.43	7.98	8.45	14.04	14.41	10.04
165	73.9	8.87	7.33	7.96	10.15	10.20	14.93	9.91
180	82.2	7.30	6.67	9.11	8.61	12.11	20.82	10.77
195	90.6	7.01	7.75	7.44	8.70	12.46	17.88	10.21
Ave. for time		7.69	6.76	7.50	8.34	10.92	14.43	

TABLE 2

A comparison of tenderness evaluation by the Kramer Shear Press and by a panel of 5 judges (tenderness judged by the number of chews necessary prior to swallowing a 1 cm. cube of meat)

Tenderometer (Lbs. of force per gram of sample)	Number of Chews	
	Average	Range
4.70	19.4	12-25
7.40	21.2	12-24
7.13	19.8	10-26
8.39	25.4	19-35
6.73	25.4	21-30
7.56	25.6	21-32
6.71	20.2	15-29
4.89	17.6	12-25
6.39	18.8	14-26
6.75	17.6	8-24
7.53	17.8	13-21
8.57	19.4	14-26
6.45	18.2	17-20
6.75	17.8	14-21
8.50	22.4	17-27
5.45	23.4	20-32
7.12	19.0	16-24
8.57	28.6	15-51
5.79	24.6	18-30
7.16	28.2	22-36
7.27	27.0	14-34
11.77	40.0	29-56
7.01	30.8	16-44
13.39	55.8	44-64
6.66	21.0	18-24
13.13	29.8	23-45
10.13	28.8	21-40
8.71	31.8	23-39
11.87	39.2	25-50
15.42	45.6	36-59
7.67	23.6	20-30
15.11	35.6	30-50
16.77	37.8	31-47
6.75	22.4	17-28
12.16	45.4	25-67
20.14	62.2	43-84

SUMMARY

Within the limits of this study time of scald and temperature of scald significantly reduced tenderness of poultry meat as does the interaction of time with temperature.

Within the range of times and temperatures used in this study the effect of time was greater than that of temperature.

There is a high correlation between Kramer Shear Press values for tenderness and evaluation by chewing.

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Flat Sour Spoilage of Tomato Juice and Its Control with Subtilin[a]

E. Wheaton
Research Division, American Can Co., Barrington, Illinois
J. D. Burroughs and G. L. Hays
Technical Service Division, American Can Co., Maywood, Illinois

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When tomato juice was first canned in the late 1920's, it was thought that because of the low pH of the product (under 4.5) a hot fill (190° F.) would be adequate to produce a commercially sterile product. Packers of tomato juice soon learned that such a process was inadequate, as outbreaks of flat sour spoilage occurred and were investigated as early as 1931. Since those first outbreaks, hardly a year has passed without some recurrence of spoilage.

The following review presents briefly some of the more important studies concerning sources of contamination, thermal resistance of the spores of the causative organism, and methods of controlling this spoilage.

Berry *(2)* in 1931 isolated the causative organism, a spore forming, facultative anaerobe capable of growing over a wide range of temperatures (72° to 142° F.). He proposed the name *Bacillus thermoacidurans* for this organism because of its unusual resistance to heat in an acid medium. Later studies *(5)* have disclosed the similarity of *B. thermoacidurans* to *B. coagulans* and the two organisms are now considered synonymous. In order to be technically correct, the name *B. coagulans* should be used since it has priority.

Organisms causing flat sour spoilage of tomato juice are widely distributed in nature and are, no doubt, brought into the canneries with the soil clinging to the tomatoes.

In the earlier outbreaks of flat sour spoilage of tomato juice, the spoilage was characterized by the development of a medicinal taste accompanied by a slight drop in pH *(15)*. More recently, flat sour spoilage of tomato juice has been investigated in which not only the medicinal taste but also a vinegar taste was observed. In these cases, a drop in pH of over 0.5 of a unit is often noted.

Since these spoilage organisms do not produce gas in tomato juice, the spoiled cans of juice cannot be segregated from the good product by noting swelled cans. Unlike flat sour spoilage of many low acid foods which is accompanied by considerable loss of vacuum, the flat sour spoilage of tomato juice also cannot be detected by either flip vacuum measurement or the thermal method. The case, however, is not quite clear. Pearce *(11)* and Pederson and Becker *(13)* report no loss of vacuum in flat sour cans of tomato juice whereas Stern, Hegarty and Williams *(15)* state there is always a loss of vacuum. During spoilage outbreaks, packers have noted a much higher incidence of flat sour spoilage in cans of tomato juice with 13 to 14 inch vacuums than in cans of the same lot having 17 inch vacuum. These observations have led to the controversial issue: Is the vacuum reduced by growth of the flat sour organisms or is the loss in vacuum due to microleakage with the product becoming contaminated with the spoilage organisms during a very short period of leakage?

Bacteriological surveys of cooling water and post cooling line equipment at various tomato juice canneries indicated that non-heat resistant, gas producing organisms were the predominant type. Flat sour organisms were found in much fewer numbers. These observations led to the conclusion that if microleakage were involved in any flat sour spoilage outbreak, a larger number of cans would become swells due to the greater chance of contamination with the more predominant gas-forming organisms.

In a preliminary study to learn the effect which the growth of flat sour spoilage organisms might have on the vacuum of canned tomato juice, an average difference in vacuum of 3.4, 3.5, and 3.8 inches was noted between control and inoculated cans of tomato juice which had been incubated at 98° F. for 10, 15, and 26 weeks, respectively.

EXPERIMENTAL

After the pH of commercially canned tomato juice had been adjusted to pH 4.6, the juice was flash sterilized in a tubular heat exchanger (21 seconds at 267° F.) Sterilized juice was pumped into a steam jacketed kettle and approximately 100 each of control and inoculated cans were filled at 207° F. Headspace of each can was adjusted with a topper before steam flow closing. Closed cans were inverted and held 3 minutes before being water cooled. All control cans were filled and closed before the inoculated cans and were cooled in a separate tank. Each of the inoculated cans contained a total of 126,000 spores of 4 strains of the flat sour spoilage organism which had been used in the preliminary study. All cans were incubated at 98° F. for 10 weeks.

RESULTS

Flat sour spoilage was found in all of the inoculated cans while the pH and flavor of the controls remained normal.

Minimum vacuum observed in the control lot, with the exception of one container, was higher than the maximum vacuum of the inoculated lot. Gauge vacuum readings of several cans of each lot, immediately after packing, showed an identical range of vacuum for the control and inoculated lots, 24.5 to 26.0 inches.

[a] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 11, 1956.

An average difference of 2.6 inches of vacuum (Table 1) was noted between control and inoculated lots. Statistical analysis (Table 2) indicated that this was highly significant. Gross headspace of these cans varied from 16/32 to 22/32 inches. Although the vacuum reading of these cans was greater than commercially canned juice because of the high filling temperature and the steam flow closure, the generally observed lower vacuum of the inoculated lot after incubation would indicate that bacterial activity rather than microleakage may well account for any reduction in vacuum of cans of tomato juice in flat sour spoilage outbreaks.

CONTROL OF FLAT SOUR SPOILAGE IN TOMATO JUICE

Control by plant sanitation. Berry *(2)* found that wooden equipment harbored flat sour spoilage spores. Cameron *(7)* observed that the rapid development of these organisms in partially cleaned equipment created a definite spoilage hazard. Pearce and Ruyle *(12)*, Pearce *(11)* and Williams *(17)* suggested that the prevention of spoilage depended upon control of contamination and rigid application of principles of sanitation in preparing the product.

In 1935 Cameron *(7)* suggested use of bacteriological techniques and a somewhat empirical incubation method for determining whether or not the sanitary practices used by a cannery were controlling contamination in a satisfactory manner. From time to time *(3, 9)* bacteriological and incubation methods have been modified in view of more recent findings, but the principles of the methods remain the same.

Control by pre-sterilization. Commercial experience has shown that even the most rigid application of principles of sanitation does not always prevent outbreaks of flat sour spoilage. Seaching for a more positive method of controlling spoilage, the American Can Company Laboratories in 1940 *(14, 16)* investigated flash heating of tomato juice at high temperatures in order to destroy spoilage spores. Results of these tests indicated that a process having a sterilizing value corresponding to 0.7 minutes at 250° F. would destroy the most resistant flat sour spores. Although the presterilization method offers a more positive control than other methods of processing tomato juice, isolated incidents of flat sour spoilage have occurred in plants using this method. Such spoilage has been attributed to recontamination of the juice at the filler or closing machine.

Control by pH adjustment. Pederson and Becker's *(13)* investigation on the effect of pH on the germination of flat sour spores led them to suggest the pasteurization of tomato juice adjusted to a pH of 4.25 or below as a possible approach to preventing flat sour spoilage.

Although such a procedure very likely would reduce the probability of spore germination, it would not eliminate the risk. Stern, Hegarty and Williams *(15)* have found typical spoilage to develop in juice having a pH of 4.22.

TABLE 1

Vacuum reduction in 303 x 406 cans of tomato juice resulting from the growth of B. coagulans

Sample	Incubation at 98° F.	No. of cans	Gauge vacuum (in.)		
			Min.	Max.	Avg.
Uninoculated	10 weeks	93	23.00	25.25	24.47
Inoculated	10 weeks	100	21.00	23.00	21.91

TABLE 2

Statistical analysis of vacuum differences

Incubation at 98° F.	No. of cans	Average vacuum difference	Standard error
10 weeks	193	2.6 inches	0.70

CONTROL BY THE USE OF ANTIBIOTICS

Several investigators have studied the possible use of antibiotics in the control of flat sour spoilage of tomato juice. Since 1948 and particularly in more recent years, an extensive series of tests, covering various phases of food preservation by antibiotics, have been reported. Many of these publications treat specifically a fairly wide range of foods such as peas, corn, meat, fish, poultry, soups and juice.

In 1950 Andersen and Michener *(1)* reported that subtilin in conjunction with mild heat exerted a lethal action on bacterial spores. Soon after these findings were published, the laboratories of the American Can Company initiated studies on the effect of subtilin on spores of food spoilage organisms inoculated into many of the commercially canned foods. Results of these studies, reported by Burroughs and Wheaton in 1951 *(6)*, were quite disappointing so far as the prevention of spoilage in low acid foods was concerned. However, 40 p.p.m. of subtilin prevented the development of flat sour spoilage in 20 cans of tomato juice which had been inoculated with spores of *B. coagulans (var. thermoacidurans)*. Similar results were reported by Bohrer *(4)*. He observed that subtilin failed to prevent the growth of *Cl. parabotulinum* in low acid foods, but 20 p.p.m. of subtilin inhibited the growth of flat sour organisms in tomato juice.

Dimick, Alderton, Lewis, Lightbody and Febold *(8)* reported that subtilin is relatively stable at pH 2.5 but becomes increasingly labile at pH 7.0 and above. The National Canners Association Laboratories Report *(10)* found no detectable decrease in potency of subtilin at pH 4.8 when heated for 60 minutes at 250° F. A slight decrease was noted at pH 6.1 and its potency was reduced to practically nil at pH 8.0 when given the same heat treatment.

The apparent effectiveness and stability of subtilin in acid media coupled with the favorable reports on the effectiveness of this antibiotic in the prevention of flat sour spoilage of tomato juice led to a more extensive investigation with tomato juice.

EXPERIMENTAL

Tomato juice was obtained from a local packer directly after the cans were closed and the product frozen. Later a second pack was made using commercially processed juice secured from one source. The pH of all juice used was adjusted to 4.5 and the product was thoroughly blended. Aliquots of the adjusted juice were removed to small kettles for heating and packing. Juice for the first pack (A) was heated to 190° F. with a final closing temperature of 180-185° F. and processed for 5 minutes at 212° F. before water cooling. For the second pack (B) the juice was heated to 195° F. and filled at that temperature; the cans were then closed, inverted and held for 5 minutes before water cooling.

Inoculum for both packs of tomato juice consisted of 4 separate spore suspensions prepared from 4 strains of *B. coagulans (var. thermoacidurans)* obtained from the National Canners Association Research Laboratories. Spores were produced by growing on Difco thermoacidurans agar for one week at 131° F. and washing the growth from the slants with sterile distilled water. All spore growths then were refrigerated until used. Both packs were inoculated from the same suspensions, but the spore concentrations were varied.

Subtilin used in this work was furnished by Dr. H. Olcott of the Western Utilization Research Branch of the U. S. Department of Agriculture.[b] The dosage was calculated to yield 10 and 20 p.p.m. of subtilin for the first and 5 p.p.m. for the second pack. In Pack A the two higher subtilin concentrations were employed with a low spore concentration, whereas in the second experiment a low subtilin level with a high spore concentration was employed.

In each experiment all uninoculated cans were filled, closed, and water cooled before the inoculated lots were packed. Next in order of packing were the cans containing only subtilin, followed by the cans containing spores and subtilin, and then cans receiving only spores of the test organisms. Where both subtilin and spores were used, the required amount of subtilin (in water) was first added after which the can was half filled with hot juice. Then the inoculum was added and the fill of the can completed with hot juice.

After cooling, the packaged product samples were removed and spore counts were made on the subtilin-free cans. All other cans were placed in 98° F. storage. Examinations were made periodically for a period of one year.

RESULTS AND DISCUSSION

Table 3 shows the survival data on those packs containing inoculum but no subtilin. Since plating of lots containing subtilin could not be depended upon as an indication of spore survival, these data must be assumed to be an index of spore survival in comparable lots to which subtilin was added.

Flavor results (See Table 4) of the experimental work with subtilin involving the packing of a total of 700 (211 x 400) cans of tomato juice with an adjusted pH of 4.5 are as follows:

Five hundred and fourteen cans containing subtilin in quantities of 5, 10, and 20 p.p.m. and spores of *B. coagulans (var. thermoacidurans)* in concentrations ranging from 6 to 910 per ml. of juice were examined at intervals for off-flavor spoilage during 12 months' storage at 98° F. No off-flavor spoilage was detected by taste tests and there was no significant drop in pH as may be associated with this type of spoilage.

No off-flavor spoilage occurred in the 27 cans having neither subtilin nor spores and held under the same conditions, nor in the 36 cans containing 5, 10, or 20 p.p.m. of subtilin and no spores. Of the 123 cans inoculated with only the spores of the test organism, off-flavor was detected in 118 cans or 95.9%.

Assays on the subtilin were made according to the procedure described by the N. C. A. Laboratories *(10)*. These assays were made during the one-year storage period. The procedure involved addition of the juice to Brom Cresol Purple dextrose broth and serial dilutions made in the same medium. A standardized spore suspension of F. S. 1518 was added to each tube so that there were approximately 30,000 spores per ml. Absence of subtilin in a respective dilution tube was indicated by acid production in the medium and residual subtilin was calculated according to the formula given by the N. C. A. Laboratories *(10)*. An appreciable drop in the subtilin content was noted after 5 months' storage. After 12 months' storage the estimated subtilin content of the juice in packs A and B was approximately 1 p.p.m. and the pH values ranged from 4.2 to 4.46.

On each occasion that the samples were cut for tasting and examination a panel of from 3 to 6 persons cognizant of the off-flavor spoilage participated. Spoilage was readily detected in inoculated untreated lots, but no significant differences were noted between the treated inoculated lots and untreated uninoculated lots.

Attempts were made during the early storage period to recover spores from treated samples but such recovery could not be achieved by the usual procedure. Samples held for 5 months were sent to Dr. L. E. Sachs of the Western Utilization Research Branch of the U. S. Dept. of Agriculture to attempt recovery of spores by a method he had employed. Dr. Sachs replied that "the samples contained vey few viable spores; the experiments I can are incapable of detecting very small numbers of viable spores. It is likely most of the spores have been killed. The samples contained sufficient residual subtilin to inhibit development of artificial inocula."

From the results obtained it cannot be determined whether subtilin acts as a sporocide or as a sporostat. The vegetative cells produced by the germination of the spores may have been destroyed by subtilin or possibly the spores were unable to germinate in the presence of subtilin and, after prolonged storage in the acid medium, became non-viable.

[b] Present address: University of California, Department of Food Technology, Berkeley 4, Calif.

TABLE 3

Spore survival count after processing or hold

Organism number	pH	Survival count per ml. (Avg.)
Pack A (Processed 5' @ 212° F.)		
4	4.47	6
1655	4.47	25
1657	4.47	17
2253	4.47	79
Pack B (Hot fill, hold 5', cool)		
4	4.48	880
1655	4.49	103
1657	—	720
2253	4.48	910

SUMMARY

In studies on the effect of the growth of *B. coagulans (var. thermoacidurans)* on vacuum loss, the spores germinated and produced flat sour spoilage in all of the inoculated cans of tomato juice. The pH of the juice had been adjusted to 4.6.

Statistical analysis of the data, significant to the 99% confidence level, showed a definite reduction of the vacuum of those cans of tomato juice in which flat sour spoilage developed. Average difference in vacuum noted between the control and inoculated lots was 2.6 inches of vacuum after 10 weeks' incubation at 98° F.

This work also substantiated earlier findings that subtilin appears to prevent off-flavor spoilage in tomato juice inoculated with the spores of certain strains of

TABLE 4

Examination of tomato juice for off-flavor after storage at 98° F.

Code	Subtilin Spores[1]		2 Weeks		1 Month		3 Months		5 Months		7 Months		9 Months		11 Months		12 Months		Total	
	p.p.m.	per ml.	Off[2]	Norm[3]	Off	Norm	Off	Norm	Off	Norm	Off	Norm	Off	Norm	Off	Norm	Off	Norm	Off	Norm
0–0	0	0		2		1		2		2		2		2		1		2		14
0–10	10	0		2		1		2		2		2		2		1				12
0–20	20	0		2		1		2		2		2		2		1				12
4–0	0	6	2	1	1		2		2		3		1		2		1		14	1
55–0	0	25	3		1		1	1	1	1	3		1		2		1		13	2
57–0	0	17	3		1		2		2		3		2		2		1		16	
53–0	0	79	3		1		2		2		3		2		2		1		16	
4–10	10	6		2		2		3		3		3		3		3		33		52
55–10	10	25		2		2		3		3		3		3		3		33		52
57–10	10	17		2		2		3		3		3		3		4		32		52
53–10	10	79		2		2		3		3		3		3		4		32		52
4–20	20	6		2		2		3		3		3		3		4		33		53
55–20	20	25		2		2		3		3		3		3		4		32		52
57–20	20	17		2		2		3		3		3		3		3		34		53
53–20	20	79		2		2		3		3		3		3		3		33		52
2–0–0	0	0		1		1		1		1		1		2		1		5		13
2–0–5	5	0		1		2		1		1		1		1		3		2		12
2–4–0	0	880	2		2		2		2		1		3		2		1		15	
2–55–0	0	103	2		2		2		1	2	1		2		2		2		14	2
2–57–0	0	720	2		2		2		1		1		2		2		3		15	
2–53–0	0	910	2		2		2		2		1		2		2		2		15	
2–4–5	5	880		2		2		3		3		3		3		3		10		29
2–55–5	5	103		2		2		3		3		3		3		3		9		28
2–57–5	5	720		2		2		2		2		2								10
2–53–5	5	910		2		2		3		3		3		3		3		10		29

[1] Surviving spores after heat treatment.
[2] Number of samples showing off-flavor.
[3] Number of normal samples.

B. coagulans (var. thermoacidurans) when 5, 10 or 20 p.p.m. subtilin are employed in conjunction with mild heat treatment.

However, it should be remembered that the present U. S. Food and Drug standards for tomato juice do not permit substances such as subtilin as an optional ingredient, nor has subtilin been approved for any food uses. An extensive program of tests to answer a number of questions which have been raised by food officials about the use of subtilin or other stable antibiotics in foods would be necessary before any commercial trial use could be made of the experimental results reported herein.

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Uptake of Aureomycin[a] Chlortetracycline By Fish and Its Heat Inactivation

Tetuo Tomiyama, Yasuo Yone and Kazuo Mikajiri
Department of Fisheries, Faculty of Agriculture, Kyushu University, Fukuoka, Japan

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TARR AND HIS ASSOCIATES *(5, 6, 7, 8)* have carried out a number of studies in extending the storage life of fish fillets and eviscerated fish by treatment with chlortetracycline (CTC). They *(6)* have found CTC to be more effective than any other antibiotic employed. They have reported *(7)* a remarkable retardation of the bacterial spoilage of eviscerated fish by chilling with ice containing 1 to 4 p.p.m. CTC, by holding in chilled sea water containing 3 p.p.m. CTC, and by briefly immersing in 50 to 100 p.p.m. CTC solution before icing. Farber *(1)* has also reported that a short dip in a 2 p.p.m. CTC solution was effective in extending the keeping quality of fish fillets. Recently, Firman *et al. (2)* have demonstrated a marked prolongation of storage life by treating several different types of eviscerated fish with CTC applied as an ice (5 p.p.m.), a dip, or freezing brine (5-10 p.p.m.).

Extensive studies by Tomiyama *et al. (9, 10, 11, 12)* in Japan have also demonstrated the effectiveness of CTC in the prolongation of storage life of round fish. They have found *(9)* that a dip longer than 30 minutes in a 10 p.p.m. CTC solution and/or storage in a 5 p.p.m. CTC-ice were effective in extending the keeping qualities of the round sardine. It was also observed that the effectiveness of CTC did not increase in proportion to its concentration in the range of 10 to 40 p.p.m. Storage of round mackerel in a 20 p.p.m. CTC-brine solution for 1-2 hours at room temperature extended the storage life 1.4 to 2.6 times that of the untreated group *(10)*. They have further reported *(11)* that the storage life of Pacific round herring could be extended 40 to 90% more than the controls when the fish were stored in CTC-sea water and in CTC-ice immediately after being caught. The storage of several bottom fish has also been extended by dipping in sea water containing CTC and/or holding in CTC-ice while on board the trawler *(12)*.

From these studies it is firmly established that the control of bacterial spoilage of fillets, eviscerated, or round fish can be achieved by the proper use of CTC.

Only limited data, however, are available on the distribution of CTC in various parts of the fish and on the stability of the CTC in fish muscle when heated at varying temperatures; on these aspects the only reports seen by the authors are those of Tarr *et al. (7, 8)*. Their data show CTC to be fairly stable in the flesh of gray cod at low temperatures but to be readily destroyed by boiling.

From the standpoint of the food technologist such data are greatly needed. Therefore, the purpose of this paper is to obtain more information on the uptake of CTC by several round fish and to study its distribution in fish muscle and its destruction by heat in fish muscle.

[a] Aureomycin is the trademark of the American Cyanamid Company for the antibiotic chlortetracycline.

EXPERIMENTAL

Assay of CTC in fish flesh. The method of Kohler *et al. (4)* was employed with some modifications in preparing the culture media, a standard curve, and in certain other procedures.

Culture media. Since we were unable to obtain all the ingredients necessary to prepare the media of Grady *et al. (3)* and Kohler *et al. (4)* certain modifications were made. The medium employed consists of peptone (papain-digest of casein) 3.0 g., a dried yeast 1.5 g., a fish liver autolysate 0.75 g., glucose 0.5 g., acid hydrolysate of casein 20 ml. (equivalent to 2 g. of casein), agar 5.0 g. and water 480 ml. The pH of the mixture was adjusted to pH 5.5 before addition of agar.

Inoculum. Autoclave a 300 ml. aliquot of the culture medium without agar for 10 minutes at 121° C. After cooling, inoculate with *Bacillus cereus* 5 and incubate 4 days at 37° C. on a reciprocal shaker. At 48-hour and 72-hour intervals, add aseptically a manganous sulfate solution to make the concentration of manganous ion 5 μg. per ml. Centrifuge the spores of *Bacillus cereus* thus formed, and wash with 3% sterile saline. Repeat the washing procedure twice and suspend the washed spores in 30 ml. of the sterile saline. Heat the suspension for 30 minutes at 70° C. and store under refrigeration. A 2 ml. aliquot of this suspension was found to be satisfactory for 100 ml. of test medium.

Extraction of CTC from tissue sample. Pulverize a 20 g. sample of tissue in 100 ml. of an extractant consisting of 65 parts of acetone, 30 parts of water and 5 parts of 4 N hydrochloric acid with a Waring blender. Adjust to the original volume by adding the extractant and mix well. Then, centrifuge for 3 minutes at 2,500 r.p.m. Adjust the supernatant to pH 4.2 with 10 N sodium hydroxide solution. This extract is assayed for CTC.

Standard curve. Grady *et al. (3)* and Kohler *et al. (4)* prepared a standard curve from untreated tissue extracts. However, when this standard curve was employed in our laboratory, a recovery of only 85 ± 2% was obtained. This may have been due to difficulties in the extraction of CTC, some of which may have been bound to the tissue proteins. Therefore, the following modification was made in the preparation of the standard curve.

Mix 200 μg. of CTC with a 20 g. aliquot of the finely ground untreated sample. Extract the CTC as before. Dilute the extract with an equal volume of the untreated tissue extract. Repeat successively 1:1 dilution until the CTC concentration lowers down to 0.062 μg. per ml. Test all the diluted extracts according to the following procedure for assay. The standard curve can be obtained by plotting values for the diameter of the inhibitory zone against logarithms of the corresponding concentrations.

Assay procedure. Autoclave a 25 ml. aliquot of the culture medium for 10 minutes at 121° C. Cool to approximately 60° C., mix a 0.5 ml. aliquot of the spore suspension of *Bacillus cereus* No. 5, and pour the mixture into a Petri dish of 7-inch diameter. Dip a filter paper disc (Carl Schleicher and Schull No. 740-E, ¼ in.) into the sample extract. Remove any excess of sample extract and place the filter paper on the agar plate described above. After refrigerating the agar plate for 1 to 2 hours at 4° C., incubate for 12 hours at 27° C. Measure the diameter of the inhibitory zone formed and obtain the corresponding concentration of CTC from the standard curve. All the assay values reported are averages of triplicate determinations.

Materials and treatment procedures. *CTC preparation and CTC-sea water.* The CTC preparation employed was supplied by the Japan Lederle Co. and assayed 89%. The CTC-sea water for dip treatments contained 10 p.p.m. of CTC and 100 p.p.m. citric acid. The resulting solution had a pH of 5.2.

The temperature of the solution was adjusted to 4° C. before use.

Rate of uptake of CTC by round fish. Several species of fish were used, i.e., pilchard *(Sardinia melanosticta)*, common mackerel *(Scomber japonicus)*, horsemackerel *(Trachurus japonicus)* and "madai" or red sea bream *(Pagrosomus major)*. These were obtained from a local market and observed to have fairly good quality. For CTC uptake studies sample round fish were placed in the CTC-sea water in a ratio of approximately 200 g. of fish per liter. As a precaution against decrease in CTC-concentration a renewal of CTC solution was made every 30 hours. At various intervals, samples were removed and washed with a relatively small volume of distilled water. The fish was scaled and cut into appropriate pieces. These sample pieces containing skin were ground, extracted, and assayed as described above.

Distribution of CTC in various parts of round fish. Use was made of very fresh "isaki" *(Paropristipoma trilineatum)* which were sampled directly from a fishing boat. The round fish were placed in the CTC-sea water at 4° C. before rigor mortis. Samples were removed at intervals, lightly rinsed, and various parts of the fish assayed for CTC.

Decrease in CTC-concentration after dipping round fish. Two horse-mackerel, about 160 g. total weight, were first dipped in 160 ml. of the CTC-sea water at 4° C. for 30 minutes. Three separate lots of fish weighing 160 g. each were then immersed for 30 minutes one after another in the same CTC solution. The CTC-concentration after each dip treatment was determined.

CTC-uptake by fish fillets. Several blocks of bonito flesh (about 5 cm. cube) were immersed at 4° C. in one liter of the CTC-sea water. One hour and 5 hours after immersion, samples were removed and lightly washed. Portions of 0-10 mm. and 10 to 20 mm. were dissected from the surface of the block and assayed for CTC.

Heat stability of CTC which penetrated into the flesh. Several small blocks of bonito flesh, 3.0-3.4 g. in weight and about 1.3 cm. cube in size, were immersed in an aqueous solution of CTC (50 p.p.m.) for 3 hours at 4° C. Samples were removed, washed with a small amount of distilled water, and assayed without cooking. The results indicated an average CTC content of 21 p.p.m. Three blocks of the fish fillets were placed in large test tubes containing 10 ml. of water and stirred slowly at 55°, 76°, and 93° C. Care was taken not to disintegrate the blocks. At various intervals, samples were removed and assayed for CTC as previously described.

RESULTS AND DISCUSSION

Uptake of CTC by several round fish. The CTC content of round fish after storage at 4° C. in sea water containing 10 p.p.m. CTC for various periods is summarized in Table 1. Results show that no detectable CTC was found within a 27-hour storage except in case of pilchard and small common mackerel. Uptake of CTC by these fish may be accounted for by the fact that their skin is rather thin and they are not completely covered with well-developed scales. Higher values for CTC in these samples may also be correlated with a relatively high percentage of skin which may take up CTC as shown in Table 2.

TABLE 1

CTC content (p.p.m.) of round fish after storage for various time intervals at 4° C. in sea water containing 10 p.p.m. CTC

Kinds of fish	Ave. body length (cm.)	Hours of storage					
		0	2	6	27	50	70
Pilchard[1]	7	0	1.0	1.0	4.0		
Pilchard[1]	13	0	1.0	1.6	2.7	2.8	
Common Mackerel[2]	14	0	1.0	1.5	2.1		
Common Mackerel[2]	25	0	0	0	0		
Horse Mackerel[3]	19	0	0	0	0		2.8
Horse Mackerel[3]	24	0	0	0			
"Madai"[4]	8	0	0	0	0	0	

[1] *Sardinia melanosticta.* [2] *Scomber japonicus.* [3] *Trachurus japonicus.* [4] *Pagrosomus major.*

TABLE 2

CTC content (p.p.m.) in various parts of round fish, "isaki" (Paropristipoma trilineatum) after storage in CTC-sea water (10 p.p.m.) at 4° C.

Tissue	Hours of storage			
	0	2	6	27
Flesh	0	0	0	0
Viscera	0	0	0	0
Skin	0	1.0	1.0	1.0
Gills	0	1.0	1.0	1.0

It is of interest that CTC is found in the skin and gills of "isaki", but not in the flesh (Table 2). These data indicate also that the skin of this fish takes up CTC rather quickly but is saturated within a very short time. Similarly, when horse-mackerel was placed in the CTC-sea water for 6 hours at 4° C., CTC was not found in a steak just under the skin nor in a center steak which was located 5-10 mm. under the skin. These data clearly indicate that round fish immersed in sea water containing 10 p.p.m. CTC may take up CTC in the epithelium, but that penetration of this barrier by CTC is ordinarily very difficult. This result is of particular importance in explaining the mechanism of preservation in fish treated with CTC. The data suggest that, in round fish, CTC inhibits bacterial growth on the surfact, thus preserving the integrity of the skin barrier and thereby delaying the penetration of bacteria into the flesh. From these considerations it is easily understood why immediate treatment with CTC after catching is necessary to obtain the remarkable effectiveness of this antibiotic in extending storage life *(11)*.

The difficulty of absorbing CTC by round fish was also demonstrated in the experiment where 4 different samples of horse-mackerel were dipped for 30-minute periods successively in the same sample of sea water at 4° C. The concentration of CTC was 10.0, 10.1, 10.1, 10.1 and 9.8 p.p.m. at the start, after the first, the second, the third, and the fourth dip, respectively. Negligible quantities of CTC had been removed from the solution even after the fourth dipping operation.

Recently Tarr *(8)* has reported that in eviscerated gray cod refrigerated with ice containing CTC there was only a slight penetration after several days' storage, and this occurred principally in visceral cavity samples with skin attached. He also presented data that eviscerated fish stored in refrigerated sea water containing CTC absorbed the antibiotic more markedly than did CTC-iced fish. Taking into consideration the authors' and Tarr's data, it is quite certain that any penetration of CTC into flesh does not occur when round fish are kept in CTC-ice under commercial condition.

Uptake of CTC by fish fillets and inactivation of CTC by heating. Uptake of CTC by bonito fillets (without skin) from sea water containing CTC has been determined, as previously described. Results are presented in Table 3. These data indicate that the muscle near the surface does pick up a small amount of CTC, but that none penetrates deeper than 10 mm. under the conditions of this experiment. Firman *et al. (2)* have also shown that the uptake of CTC by raw scrod steak was greater than that by whole eviscerated butterfish.

As to the heat stability of CTC in fish muscle, Tarr and his associates *(7)* have shown that when ground

TABLE 3

CTC contents (p.p.m.) of Bonito muscle after storage in CTC-sea water (10 p.p.m.) at 4° C.

Depth of sample flesh as measured from its surface	Hours of immersion	
	1	5
0-10 mm.	1.2	2.4
10-20 mm.	0	0

lingcod or coho salmon flesh containing 5 μg. of CTC per gram was heated at 100° C., only about 10% of the initial concentration was recovered after heating for 30 minutes. Recent data of Tarr *(8)* indicate that heating fish to an internal temperature of 82° and 99° C. will destroy from 80 to 90% of added CTC. However, no data are available on the rate of destruction of CTC at other temperatures. Employing bonito fillets which absorbed 21 μg. of CTC per gram, the instability of CTC was determined at 55°, 76° and 93° C., as previously described. The results summarized in Table 4 indicate that approximately 50% of the CTC was destroyed within 60 minutes at 55° C. while 100% was destroyed at 76° C. or 93° C. when heated for the same period. Figure 1 illustrates the relationship between the residual CTC in the bonito fillets and the duration of heating. When values for the residual CTC are plotted against the logarithm of the time of heating, straight lines are obtained for each temperature. From these curves one can estimate that the time required to reduce this magnitude of CTC in this fish muscle to 10% would require approximately 26 minutes at 93° C. and 45 minutes at 76° C. Under practical cooking conditions the heat destruction of CTC in round fish will occur more rapidly, since the skin containing the highest concentrations will be heated much more rapidly than the interior muscle tissue.

SUMMARY

Uptake, distribution, and heat destruction of CTC in four species of round fish and in fish fillets were determined by a modified pad plate assay.

CTC did not penetrate into the muscle tissue of round fish from chilled sea water containing 10 p.p.m. within one day of immersion except in the case of small fish with incompletely developed scales, e. g., pilchard, common mackerel.

Determination of CTC in various parts of fresh round fish "isaki" which were stored in chilled sea water containing 10 p.p.m. of CTC gave results which indicated that the penetration of CTC into flesh or viscera did not occur after 27 hours' storage whereas a measurable uptake did occur rather rapidly into the skin and gills.

Evidence was obtained that the surface part of bonito muscle (without skin) picked up as much as 2.4 p.p.m. CTC over a 5-hour period when immersed in sea water containing 10 p.p.m. at 4° C., whereas no CTC was found in the muscle deeper than 10 mm.

The rate of heat destruction of CTC in bonito muscle increased remarkably as the temperature was raised. The change in residual CTC can be expressed as an exponential function of time of heating.

TABLE 4

Residual amount of CTC in Bonito fillets after heating at varying temperatures

Time of heating (minutes)	Temperatures					
	55° C.		76° C.		93° C.	
	p.p.m.	%	*p.p.m.*	%	*p.p.m.*	%
0	21.0	100	21.0	100	21.0	100
5	16.0	76	14.0	67	13.0	62
10	15.0	71	10.7	54	8.7	41
30	11.0	52	4.0	19	1.6	7.6
60	10.5	50	0.0	0.0	0.0	0.0

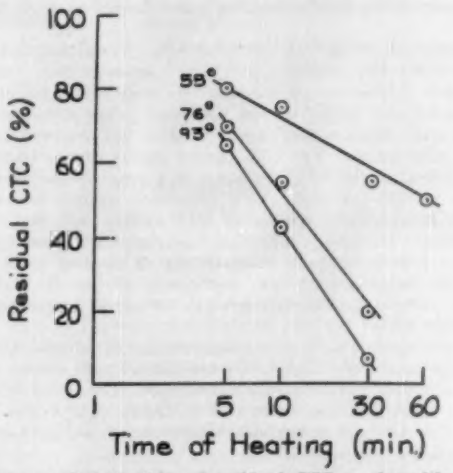

Figure 1. Relationship of residual CTC vs. logarithms of time of heating.

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Observations on the Color of Vacuum-Dried Tomato Juice Powder During Storage

Francis F. Wong and George S. Behart
Western Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture, Albany 10, California

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Carotenoid pigments including lycopene, the principal coloring matter in ripe red tomatoes, have been studied by many investigators. Extraction of these compounds from tomato products has been reported by Davis *(1)*, Wilstätter and Escher *(11)* and others; methods for the determination of carotenoids in tomato products have been described by a number of workers including McCollum *(6)*, Friedman *et al. (2)*, Snell and Snell *(9)*, Strain *(10)*, and Zscheile and Porter *(17)*. The nature of the carotenoid compounds has been described by Kuhn and Grundman *(5)*, Palmer *(8)*, and in detail in a series of papers by Zechmeister and co-workers *(13, 14, 15, 16)*.

In the course of our studies on tomato-juice powders, it was considered desirable to investigate possible changes in color under various storage conditions. The results of a storage study on flavor of vacuum-dried tomato juice have been reported *(12)*. This communication presents our observations on color during that study and also a method for the preparation of small quantities of high-purity all-trans lycopene, used in the preparation of spectrophotometric standard solutions.

METHODS AND MATERIALS

Lycopene. Determination of lycopene was carried out by a modification of the method described by McCollum *(6)*, as follows: One gram of tomato powder was mixed thoroughly with 2 g. of Celite and further mixed with sufficient water to produce a smooth paste containing 10% tomato solids. After 5 minutes, 100 ml. of 95% ethanol was slowly stirred into the paste, followed by addition of 50 ml. of acetone. One hundred ml. of petroleum ether (b.p. 63° to 70° C.) was then added and the entire mixture stirred for 5 minutes with just sufficient agitation to keep all the solids in suspension. Four hundred ml. of water were added and the stirring continued for 2 more minutes. After the mixture had stood for 5 minutes, the upper, petroleum-ether layer was filtered through a Whatman No. 3 filter paper. Ten ml. of the filtrate were transferred to a 200-ml. volumetric flask and diluted to volume with a 1:9 acetone-petroleum ether mixture. Colorimetric readings were made at wave lengths of 4,375, 4,875, and 5,020 Angstrom units with a model DU Beckman Spectrophotometer fitted with 5-cm. cells. Calculations for lycopene content were based on the formula advanced by Zscheile and Porter *(17)*. Spectrophotometric standard solutions were made from all-trans lycopene prepared as described below.

In attempting to prepare all-trans lycopene by methods given in the literature *(1, 11)*, certain difficulties were encountered which led to the development of the simple method described here.

The trans lycopene was prepared from these tomato products: commercially processed juice and paste, powder prepared in our laboratory, and red-ripe raw fruit. The pastes and powder were mixed with distilled water to produce a material containing 10% solids while the commercially processed single-strength juice was used directly from the cans. The raw fruit was comminuted in a kitchen-type blender. After removal of seeds by screening, the macerate was used as the lycopene source. Except for this preliminary treatment, the procedure followed was identical for each raw material.

Five hundred ml. of the prepared tomato product were measured into a blender cup. Chloroform was added in the ratio of 20 ml. per 100 ml. of tomato product. After blending vigorously 2 to 3 minutes, the emulsion was transferred to 100-ml. tubes and centrifuged 5 minutes at 1,500 r.p.m.

The bottom layer of chloroform was filtered through Whatman No. 12 paper to obtain a water-free extract. This chloroform filtrate was evaporated to apparent dryness by a stream of CO_2 gas.

To eliminate most of the more soluble unwanted materials, the dry residue was broken up and extracted 3 successive times with 5-ml. portions of cold acetone, and these extracts were discarded. The residue was then extracted with successive 20-ml. portions of hot acetone until most of the red pigment had been removed. It was found convenient to rotate the extraction flask with the 20-ml. charge of acetone in a hot-water bath until the acetone reached the boiling point. The hot supernatant was passed through a Whatman No. 12 filter paper and collected in a 50-ml. Erlenmeyer flask. Each charge of acetone was handled in this manner and the filtrates in separate flasks were reheated in the water bath to insure that all of the material was in solution. Each flask was then stoppered and placed in the dark until crystallization was completed—from 4 to 12 hours with the shorter time prevailing.

The crystalline product was collected in a 2-cm. medium fritted glass Büchner funnel and washed first with a small amount of cold acetone following by petroleum ether (b.p. 63 to 70° C.) and finally a second portion of acetone with aspiration to minimize solvent action.

The dark-red needle-like crystals (Figure 1) were dried under a high vacuum over anhydrous $CaCl_2$ and then stored, until used, in the dark under either vacuum or inert atmosphere.

The melting point of the product was 168.0 to 168.5° C. corrected. Recrystallization from chloroform-methanol in the manner described by Fraps and Kemmerer *(3)* yielded crystals with the same melting point.

The standard spectrophotometric solutions were made up from these crystals with petroleum ether.

Soluble color and subjective appraisal. Having been reported previously *(12)*, these findings will not be discussed further here. The results of the water-soluble color analyses are, however, included in this presentation for the sake of comparison with the other observations, since this factor also influences the overall color changes in tomato powders.

Color difference. Overall color changes were studied by reflectance measurements with a Hunter Color and Color Difference Meter *(4)*. For these observations, tomato powders were reconstituted to a juice of 6.5° Brix by addition of water. Aliquots of these juices were used for both flavor and color appraisals by trained panels and for the reflectance measurements.

TABLE 1

Lycopene and soluble color analyses—vacuum-dried tomato-juice powders

	Lycopene[1,4]							Soluble color[2]						
	N_2 No desiccant	N_2 Desiccant	Air No desiccant	Air Desiccant	Air Desiccant SO_2	Vacuum No desiccant	Vacuum Desiccant	N_2 No desiccant	N_2 Desiccant	Air No desiccant	Air Desiccant	Air Desiccant SO_2	Vacuum No desiccant	Vacuum Desiccant
70° F. (21.1° C.)														
6 weeks	1146	.....	1136	1118	1135		1193	0.20	0.23	0.22	0.22	0.19	.....	0.21
3 months	1202	1211	1143	1110	1132		1189	0.20	.....	0.21	0.22	0.18	.....	0.20
6 months	1347	1319	1112	1112	1121		1263	0.20	0.20	0.21	0.22	0.22	.....	0.18
12 months	1320	1324	1084	1072	1058		1243	0.16	0.22	0.21	0.22	0.20	.....	0.21
90° F. (32.2° C.)														
6 weeks	1190	1139	.....	1095	1125	1136	1118	0.24	0.22	.....	0.21	.....	0.23	0.22
3 months	.....	1196	.....	1085	1113	1215	1108	.....	0.22	.....	0.20	.....	0.26	0.21
6 months	1311	1288	.....	1076	1146	1292	1254	0.30	0.21	.....	0.20	.....	0.33	0.21
12 months	1364	1336	.....	1084	1108	1331	1355	0.58	0.22	.....	0.23	.....	0.55	0.23
100° F. (37.7° C.)														
6 weeks	.....	1133	.....	1130	1111	.....	1133	.....	0.22	.....	0.23	.....	.....	0.22
3 months	.....	1156	.....	1073	1118	.....	1156	.....	0.24	.....	0.24	.....	.....	0.23
6 months	.....	1221	.....	1061	1103	.....	1216	.....	0.21	.....	0.22	.....	.....	0.23
12 months	.....	1341	.....	1079	1103	.....	1351	.....	0.26	.....	0.24	.....	.....	0.25

[1] Expressed as Micrograms per gram moisture free powder.
[2] Expressed as Optical Density = 2 — log G.
[4] Control: N_2, no desiccant, —10° F.; Avg. Lycopene value: 1189 mcgm./gram.

One hundred twenty-five-ml. aliquots of reconstituted juice were used for each reflectance measurement. Circular glass cells 3½ inches in diameter by 1 inch depth with thin flat colorless glass bottoms were used. Reflectance off the bottom of the cell was taken through the large illuminator aperture of the color difference device. The color standard employed was a red tile, No. 33, obtained through the courtesy of Campbell Soup Company. The standard settings for this tile were as follows: $Rd = 7.0$, $a = +34.0$, $b = +16.2$.

OBSERVATIONS AND RESULTS

Analyses of the storage-study samples for lycopene showed that air-packed materials retained the lowest lycopene levels. Results of the analyses, shown in Table 1, indicate that in-package desiccation and storage temperature do not have any apparent effect on lycopene retention or loss in the samples. The presence of sulfite in the tomato powder appears to impart a slight beneficial effect, but the extent of this effect cannot be deduced at this time. All the air-packed samples showed progressive loss of lycopene throughout the storage period. In contrast to these findings, the lycopene levels of the samples packed under CO_2, N_2, or vacuum showed initial loss, but in the 6- and 12-month examinations showed apparent recoveries to a level approaching that of the lycopene content of the tomato concentrate from which the experimental powders were made.

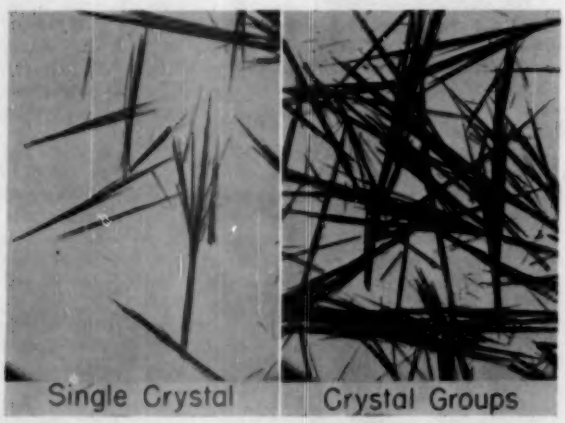

Figure 1. Lycopene crystals prepared by the method described, × 50.

Figure 2 summarizes the lycopene findings. The individual curves have been plotted to indicate the percentage of deviation of the lycopene levels of experimental materials from the control. Control samples were packed under N_2 gas without in-package desiccation and stored at —10° F. The mean value, derived from analyses of a number of these control samples at the various stages of storage, have been plotted to produce the curve *C* in Figure 2. The horizontal lines *A* and *B* represent the lycopene levels of the tomato juice and its concentrate from which the experimental powders were made. Curve *E* shows the trend of lycopene changes in the air-packed samples. Analyses of samples packed under N_2, vacuum, or CO_2 gave results very similar to one another but different from those of the air packs. Therefore, these results were averaged and plotted to give the curve *D*, which illustrates the mean lycopene values of these materials. The graphs thus obtained indicate rapid decreases in lycopene levels of all samples up to 6 weeks of storage. The curve for the air-packed materials shows continuing gradual losses to a level almost 10% lower than the mean value for the control material at the end of our study.

As indicated earlier in this paper, the N_2, CO_2, and vacuum-packed materials showed progressive recovery of lycopene to a level 12% higher than the control for the same length of storage. Table 2 showing average lycopene values for materials packed under both air and inert atmospheres at each of the 4 main storage intervals, summarizes the trend in the changes described above.

A number of publications, especially those of Zechmeister *et al. (13, 14, 15, 16)*, have reported the tendency of lycopene compounds to isomerize from one form to another with accompanying color changes. It

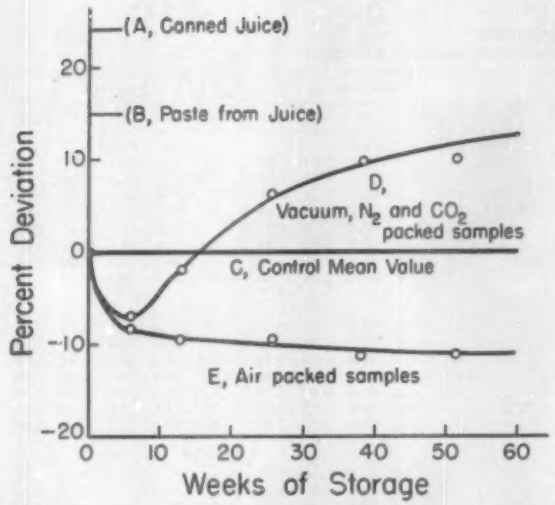

Figure 2. Lycopene in tomato powder. Percent deviation of experimental values from mean control values.

is possible that this mechanism may be responsible for the lycopene changes we have observed. We cannot, however, advance any specific explanation for this phenomenon on the basis of our limited experiments.

Results of the reflectance measurements together with the ratio a/b, which is used as a measurement of hue, and the overall color difference of the samples (ΔE) from their respective controls are presented in Table 1. For the calculation ΔE, the usual formula, $\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$ was used *(4)*. For this purpose, the *Rd* values were converted to *L* values by use of a curve plotted from the formula:

$$L = f_y Rd$$

$$\text{where} \quad f_y = 0.51 \frac{(21 + 0.2Rd)}{(1 + 0.2Rd)}$$

The color saturation values $\sqrt{a^2 + b^2}$ have not been included in this table since they do not appear to indicate any significant trend. Changes in hue (a/b values), though small, present a picture more easily followed. These changes in the tomato-juice powders represent a shifting of the hue from the normally accepted red color to one which is more yellow- or orange-red.

In the series stored at 70° F., the a/b values of the air-packed material despite in-package desiccation were consistently lower than those of controls and other samples indicating that the hue had changed toward yellow. An apparent low in the values occurred at the 6 month storage interval with a slight rise at 12 months.

The lower values of a/b in the air-packed samples were also evident in the 90° F. and 100° F. series. In these series, however, no apparent minima were observed and the decline in a/b continued throughout the 12 months. The effect of temperature acceleration of this change was small but definite.

Values obtained for ΔE indicate that the air-packed samples showed the greatest overall color change from that of the controls, a finding which is not too surprising in view of the observations on hue. One may expect, then, that the ΔE values would parallel those of the hue. A study of Table 2 shows that while this is generally true, there are nevertheless some exceptions.

In addition to the air-packed samples which declined progressively in color quality with increasing length of storage, it was found that in the 90° F. series the non-desiccated samples packed under vacuum or nitrogen gas showed marked increases in ΔE. In the air-packed samples, the changes in ΔE observed at 6 weeks through 12 months of storage increased from 1.29 and 1.62 to 2.34 and 2.92 for sulfited and pure tomato powders, respectively. During this period, the ΔE values for the non-desiccated N_2 and vacuum-packed tomato powders increased from 0.32 and 0.02 to 2.37 and 2.31. This would indicate that major changes in color quality occurred in the air-packed powders within the first 6 weeks. However, a comparable amount of change in the N_2 or vacuum-packed material did not appear until after 6 months of storage despite the lack of in-package desiccation. The color quality, hue (a/b values), remained essentially unchanged in these N_2 and vacuum-packed samples of the 90° F. series. Powder samples in the 100° F. series all showed progressive deterioration of overall color quality (ΔE) despite in-package desiccation. Air-packed powders again showed the greatest quality losses. Changes in a/b values were more definitely measured in these samples of the 100° F. series. This trend is less pronounced in the samples of this series packed under inert atmospheres and also in the air-packed samples of the 90° F. series.

TABLE 2

Average lycopene values for inert gas and air-packed tomato powders at various intervals of storage

Storage period	Inert atmosphere		Air	
	Lycopene level[1]	% Change[2]	Lycopene level[1]	% Change[2]
6 weeks	1148	−3.4	1121	−5.7
3 months	1179	−0.84	1110	−6.6
6 months	1279	+7.6	1104	−7.1
12 months	1329	+11.8	1084	−8.8

[1] Expressed as micrograms per gram of moisture free powder.
[2] Percent deviation from average control values for storage periods: 1189 mcgm.

SUMMARY

Observations on the color stability of vacuum-dried tomato-juice powder indicate that overall color differences from control samples are most marked in air-packed materials. The fact that these overall differences (ΔE) do not necessarily parallel the measured changes in hue (a/b readings from a color difference meter) suggest the existence of more than one factor contributing to color stability. Nonenzymatic browning, measured by soluble color analyses, affects the ΔE values and is in turn influenced by in-package desiccation. On the other hand, lycopene changes are not affected by in-package desiccation but show progressive deterioration in air-packed samples. An apparent recovery of the lycopene level is indicated in vacuum- and nitrogen-packed tomato-juice powder after prolonged storage.

Acknowledgment

The authors wish to thank Glen Bailey for the spectrophotometric analyses of the pure lycopene preparations, Francis

TABLE 3

Reflectance measurements[1]
Vacuum dried tomato powder reconstituted to juice of 6.5° Brix

Storage period	6 weeks					3 months					6 months					12 months				
Packaging medium	Rd	a	b	ΔE^2	a/b	Rd	a	b	ΔE^2	a/b	Rd	a	b	ΔE^2	a/b	Rd	a	b	ΔE^2	a/b
70° F. (21.1° C.)		(+)	(+)				(+)	(+)				(+)	(+)				(+)	(+)		
N_2 no desiccant	6.9	32.6	16.7	0.45	1.95	6.8	33.2	16.6	0.22	2.00	6.7	31.1	16.0	1.63	1.94	6.7	33.5	16.5	0.45	2.03
N_2 desiccant	6.9	32.6	16.7	0.45	1.95	7.1	32.3	17.0	1.24	1.90	6.7	31.7	16.2	1.00	1.96	6.7	33.4	16.3	0.64	2.05
Vacuum	6.9	32.6	16.9	0.40	1.93	6.7	32.5	16.4	0.92	1.98	6.6	31.4	16.4	1.31	1.91	6.7	32.9	16.7	0.66	1.97
Air no desiccant	7.3	31.8	17.4	1.58	1.83	7.3	32.0	17.5	1.84	1.83	7.2	30.6	17.2	2.28	1.78	7.2	32.3	17.5	1.62	1.84
Air desiccant	7.4	31.7	17.9	2.03	1.77	7.3	32.3	17.6	1.75	1.83	7.3	30.2	17.3	2.73	1.74	7.5	31.8	17.7	2.47	1.80
Air desiccant; SO_2	7.3	32.4	17.5	1.24	1.85	7.3	31.5	17.3	2.17	1.82	6.7	30.4	17.5	2.76	1.74	7.4	31.4	17.3	2.55	1.82
CO_2 desiccant	....	....	....	....	....	....	....	....	....	....	6.8	32.2	16.6	0.40	1.94	6.8	33.5	16.4	0.50	2.04
Control[3]	6.9	33.0	16.9	....	1.95	6.8	33.3	16.8	....	1.98	6.8	32.6	16.6	....	1.96	6.8	33.5	16.9	....	1.98
90° F. (32.2° C.)																				
N_2 no desiccant	6.7	33.1	16.8	0.32	1.97	6.6	32.7	16.0	0.51	2.04	6.6	31.0	15.9	1.07	1.95	6.3	32.0	16.1	2.37	1.99
N_2 desiccant	6.8	33.1	17.5	1.46	1.89	6.7	32.4	16.3	0.41	1.99	6.5	31.6	15.9	0.84	1.99	6.6	33.1	16.7	0.91	1.98
Vacuum no desiccant	6.7	33.0	17.0	0.02	1.94	6.6	32.5	16.0	0.32	2.03	6.4	31.2	15.8	1.22	1.97	6.4	31.8	16.2	2.31	1.96
Vacuum desiccant	6.7	32.9	16.8	0.76	1.96	6.7	32.6	16.0	0.51	2.04	6.6	31.9	15.6	0.85	2.04	6.7	32.8	16.7	0.95	1.96
Air desiccant	7.1	32.0	17.7	1.62	1.81	7.2	31.3	17.0	1.33	1.84	7.1	30.2	16.9	1.99	1.79	7.5	31.2	17.9	2.92	1.74
Air desiccant; SO_2	7.0	32.2	17.5	1.28	1.84	7.1	31.4	17.1	1.75	1.84	7.1	30.5	16.8	1.71	1.82	7.4	31.8	17.9	2.34	1.78
Control[3]	6.7	33.2	17.1	....	1.94	6.6	32.2	16.1	....	2.00	6.7	31.9	16.4	....	1.94	6.9	33.6	17.0	....	1.98
100° F. (37.7° C.)																				
N_2 desiccant	6.8	33.0	16.4	0.62	2.01	6.5	31.7	15.8	0.94	2.01	6.5	32.1	16.8	0.78	1.91	6.4	29.7	15.5	3.14	1.92
Vacuum desiccant	6.6	32.6	15.9	1.00	2.05	6.6	31.7	15.7	0.84	2.02	6.6	30.7	16.1	0.85	1.91	6.6	29.8	15.8	2.78	1.89
Air desiccant	6.9	31.9	16.8	0.47	1.90	7.0	30.5	16.6	1.97	1.84	7.1	29.3	17.0	2.58	1.72	7.1	27.2	16.7	5.12	1.63
Air desiccant; SO_2	6.9	32.0	16.8	0.44	1.90	7.0	31.0	16.6	1.53	1.87	6.6	29.5	16.9	2.29	1.74	7.3	29.0	17.0	3.43	1.70
CO_2 desiccant	6.6	33.1	16.0	0.71	2.07	6.6	31.6	15.7	0.91	2.01	....	....	....	....	....	....	....	....	....	....
Air desiccant, albumen	7.0	31.8	17.0	0.55	1.87	7.0	30.9	16.6	1.62	1.86	....	....	....	....	....	....	....	....	....	....
Control[3]	6.6	33.2	16.7	....	1.99	6.7	32.3	16.2	....	1.99	6.6	31.5	16.4	....	1.92	6.9	32.3	16.8	....	1.92

[1] Measurements at zero storage time: $Rd = 6.9$, $a = +33.3$, $b = +16.4$, $a/b = 2.03$.
[2] $\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$
[3] Control: N_2, no desiccant, −10° F.

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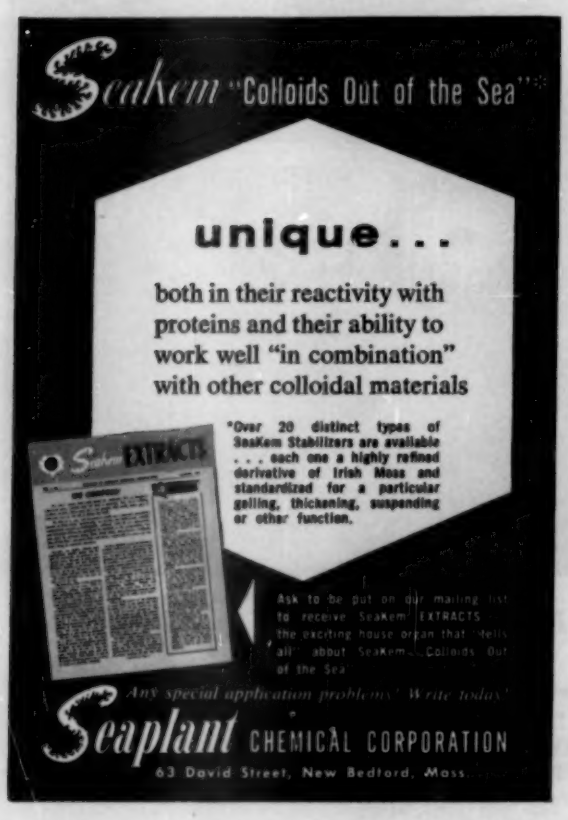
ANNUAL MEETING ANNOUNCEMENTS

(Continued from page 34 preceding technical papers)

buffet-banquet will be Paul Laesecke, Master Chef of the H. J. Heinz Company, winner of the 1956 Culinary Olympics and one of the world's most honored culinary artists.

Paul Laesecke, experimental chef, H. J. Heinz Company, will supervise the "Gourmet's Delight," Monday evening, May 12, featured feast of IFT Annual Meeting at Pittsburgh. For this colored ice carving, of fish in the modernistic style, Mr. Laesecke was awarded the grand prize in the buffet classification at the 82nd Annual Salon of Culinary Art and Exhibition of New York City, Inc.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DR. CARL A. FELLERS TO BE HONORED AT UNIVERSITY OF MASSACHUSETTS ALUMNI LUNCHEON, MAY 14

The University of Massachusetts Alumni Luncheon this year will be a testimonial honoring Dr. Carl A. Fellers. It will be held in the Aero Room of the Penn Sheraton, Tuesday, May 14, at 12:15 p.m.

The retirement of Dr. Fellers, head of the Food Technology Department at the University of Massachusetts for 16 years, was recently announced by President J. Paul Mather. Dr. Fellers' retirement in July, 1957 will mark the completion of over 30 years service at the state university. During this period he has been a dynamic force in the fields of teaching, the professional societies, and the Military.

Prof. Fellers graduated from Cornell University in 1915, and holds the M.S. and Ph.D. degrees from Rutgers University. Before joining the University staff in 1925, he taught at the University of Washington, and has since acted as bacteriologist for the U. S. Bureau of Chemistry and Soils.

During World War II, Dr. Fellers had charge of food inspection and procurement activities in Australia for the Army. He has also served as Commanding Officer of the 1224th Research and Development Unit of Springfield, Mass.

Prof. Fellers was president of the Institute of Food Technologists in 1949, and served as chairman of the Agricultural and Food Division of the American Chemical Society in the same year.

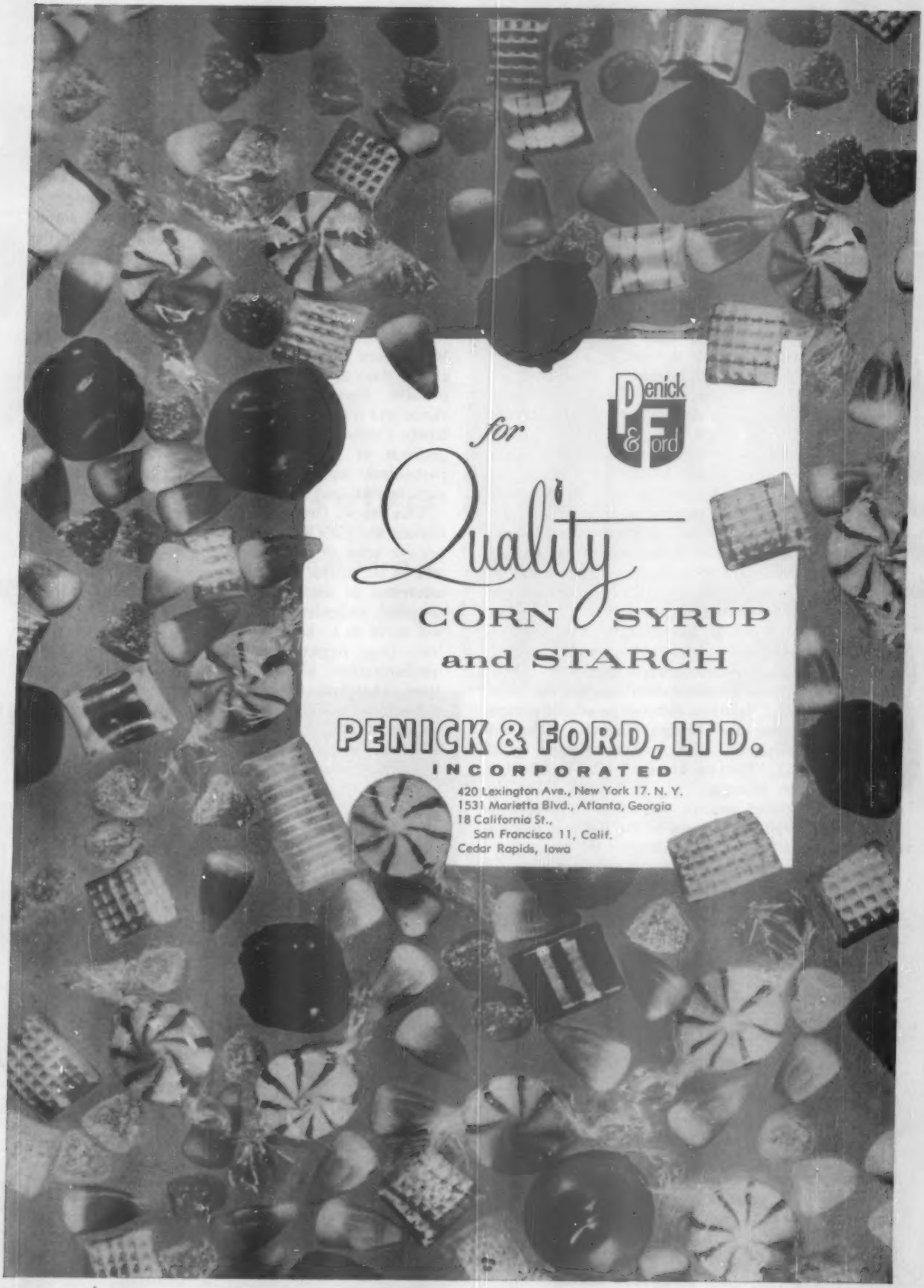
BOOKS . . .

CURRENTS IN BIOCHEMICAL RESEARCH 1956. Editor: D. E. Green, Interscience Publishers, New York, 697 pp.

The amazing advances which have taken place in biochemistry during the past decade have made it difficult for the individual to be well informed in all the fields of specialization, and this is probably particularly true for those whose occupations separate them from laboratories where the senior and outstanding research contributions are being made. The present volume makes almost ideal reading for such individuals, for it contains twenty-seven articles by biochemists with international reputations, three of them recipients of the Nobel Prize.

The introduction emphasizes the vital role which methodology has played in recent biochemical developments: use of radioactive isotopes, chromatography in its many phases, electrophoresis, spectroscopy and ultracentrifugation are mentioned. Chapters by F. Sanger and by Barbara Low and J. T. Edsall cover admirably the outstanding work which has contributed to our knowledge of the complex nature of protein structure. The nature of the reactions involved in the phenomenon of muscle contraction are discussed by M. F. Morales and Jean Botts. Some of the current developments in

(Continued on page 42)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(Continued from page 40)

ribonucleic acid chemistry and the role of nucleic acids and their derivatives in viral growth and as coenzymes are reviewed by Waldo Cohn, A. D. Hirshey and Frank Hunnekens. The biochemistry of the hemoproteins with respect to their role as oxidation catalysts and in transport and storage of oxygen is covered admirably by Britton Chance and by Phillip George, and an article by D. M. Surgenor discusses some of the important functions of blood. Some of the pioneer work which has been in progress concerning biosynthesis of sterols and in hormone action is outlined in articles by Konrad Bloch and Gregory Pincus. Other essays cover such diverse subjects as "Some aspects of vitamin and growth of factor research" (Esmond Snell), "Trends in the biochemistry of nerve activity" (D. Nachmanshon and I. B. Wilson), "An integrated concept of carcinogenesis" (H. P. Rusch) and "Chemical problems in the biochemical study of disease" (De Witte Stetten, Jr.).

The often complicated chemical syntheses and degradations which, when suitably integrated, are synonymous with living processes, are mediated by enzymes. Thus biochemistry and enzyme chemistry are inexorably linked. Few of the chapters already mentioned omit some discussion of enzymic processes, and the following deal entirely, or almost entirely, with certain of these: "Photosynthesis" (J. A. Bassham and Melvin Calvin), "Bacterial fermentations" (H. A. Barker), "Problems in cellular biochemistry" (C. F. Cori), "Enzymes as reagents" (Efriam Racker), "Attempts to formulate some basic biochemical questions" (Fritz Lipmann), "Enzyme complexes and complex enzymes" (Henry Mahler), "Relations between prosthetic groups, coenzymes and enzymes" (Hugo Theorell), "The biosynthesis of porphyrins, the succinate-glycine cycle" (David Shemin), "Enzyme kinetics" (R. A. Alberty), "Interconversion of sugars" (L. F. Leloir), "The significance of induced enzyme formation" (Spiegelman and Campbell) and "Problems in the study of multiple enzyme systems" (G. R. Greenberg).

H. L. A. Tarr
Vancouver, Canada

Biscuit and Cracker Production, by Ralph M. Bohn. Published by *Biscuit and Cracker Baker*, 71 Vanderbilt Ave., New York 17, N. Y., First edition, 278 pages, Price: $15.00.

This useful book has the secondary title, "A Manual of the Technology and Practice of Biscuit, Cracker and Cookie Manufacture, including Formulas"—which indicates its application and usefulness. Heretofore, this type of information has not been generally available in an assembled form. It fills a need and should prove valuable, not only to those in the cookie and cracker industries but also to ingredient suppliers, baking laboratory technicians, and food technology students interested in commercial baking.

The subjects covered include the chemistry of ingredients, types of machinery used, production formulas, packaging design, and the testing of materials.

Paul Holton
Chicago, Ill.

Fruit and Vegetable Preservation Industry in India. R. C. Bhutiani, Editor. Central Food Technological Research Institute, Mysore, India, 485 pages, 1956.

This little book contains the papers presented at a two-day conference at the CFTRI at Mysore in October, 1954. The 66 papers are grouped into 11 sections dealing, respectively, with raw materials, quality control, sanitation problems, nutritive value, containers, equipment, and other subjects vital to India's rapidly developing food industries.

During the past ten years top-level support and an increasingly rational organization has accomplished a great deal in driving home the important role of scientists and technologists in increasing and improving India's food supply. The change from the early stargazing days of the new India of ten years ago is impressive. For their part in this achievement, the Director and the Staff of the CFTRI should be congratulated. Finding the right level of activity is a difficult problem in a comparatively undeveloped economy, particularly with a staff which has been, for the most part, trained in Western universities.

This report (which includes presentations by many outside the CFTRI) gives a fair over-all view of the present state of the Indian food processing industries and of the major problems confronting it. For those interested in stimulating food advancements in other so-called underdeveloped countries, this little volume will serve as a veritable handbook. Many of the problems (e.g., hygiene, sanitation, or the desirability of mechanization) are common to scores of these countries. Therefore, the food administrator as well as the technologist working in such lands will find much information in this interesting and comprehensive report that will be useful in establishing a rational approach to solving specific problems as well as the more general.

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(Continued on page 44)

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FOOD INDUSTRY TOPICS . . .

in the public interest . . .

Antibiotics may provide a new approach to solving problems of malnutrition in the tropics. Dr. Elmer H. Loughlin of the New York Medical College and Dr. Norman C. Wetzel, Cleveland pediatrician and nutritionist, have reported that daily doses of terramycin have been used successfully over a six-month period to correct growth failure due to poor diets among Haitian school children. Sixty-four children were divided into four groups: two groups were given terramycin, one in doses of 50 mg. a day and the other at 10 mg. a day; the third group received 1 g. of lysine daily, and the fourth group served as a control. At the end of the test, the doctors found that those who received 50 mg. of terramycin ranked highest in growth and development progress; the lysine group ranked second; and the children who took 10 mg. of antibiotic a day ranked third. A second phase of the study, now under way and using the same groups of children, is aimed at determining the long-range benefits of the treatments.

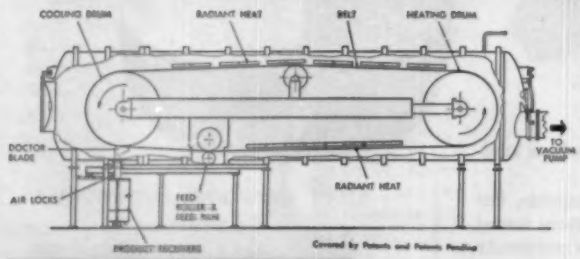
◆ ◆ ◆

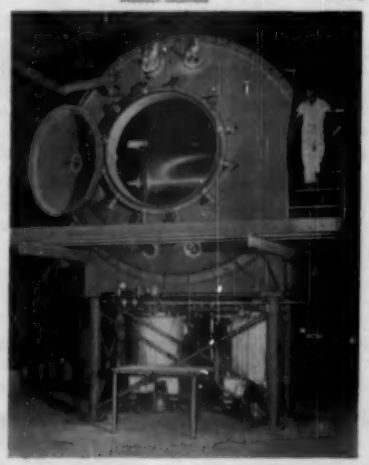
An exception to the pattern of increasing prices in the food industry was noted recently by Joseph D. Farrell, vice-president in charge of sales for Gentry, of California. Mr. Farrell pointed out that dehydrated garlic and onion seasonings, which form an important segment of the flavor industry, cost less per pound today than they did ten years ago. Mr. Farrell said that Gentry's prices for powdered onion have decreased more than 14% in the last ten years, and the price of powdered garlic has dropped more than 3%, while wage rates in the California food industry have risen more than 68% during the same period. Gentry, a division of Consolidated Foods Corp., has a dehydrating plant in the heart of the onion and garlic growing areas at Gilroy, Calif., and is a major supplier of garlic and onion seasoning.

◆ ◆ ◆

Package designers must recognize the importance of "status" in package selection. So says Dr. Ernest Dichter, of the Institute for Motivational Research, who recently completed a study to determine why consumers prefer particular types of packages and products. The study, sponsored by the Paraffined Carton Research Council, showed that every time a consumer selects a package, she is revealing a great deal about herself—her emotional needs, social longings, desire for social status. Interviewers found that package selection gives the consumer a chance to express her own image of herself. Most consumers

NEW MARKETS FOR YOUR PRODUCTS





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The Vacuum Dehydrator incorporates a continuous high vacuum process which provides volume production without loss of product quality. Dehydrated materials are characterized by fine flavor and solubility. Biological activity can also be retained in the dried product; final moisture content can be closely controlled. The result is a superior crystalline concentrate obtainable at a lower cost than was heretofore believed possible.

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naturally want to achieve higher status, and this inclination exerts a great influence on their preferences.

Research has shown that status is only one of six criteria used by buyers in judging a sound package. The others are: *convenience*—the package cannot be too bulky, but must hold enough to satisfy the customer's needs; *adaptability*—the package must fit easily into freezer, cupboard or drawer; *security*—the package must give assurance that the product is of desired quality; *dependability*—the package must create the impression that the manufacturer is reliable; and *aesthetic satisfaction*—the package must be visually appealing.

Paraffined Carton Research Council plans to publish a report, based on the study, called "The Man in the Package."

things new under the sun . . .

Precise, almost instantaneous control of liquid levels is claimed possible with a newly-developed ultrasonic level sensor. Introduced by Acoustica Associates, Inc., Glenwood Landing, N. Y., the device is said to have several advantages over currently used thermistor probes. In addition to instantaneous response, the ultrasonic probe requires no temperature correction circuits, nor are any adjustments needed to compensate for any variables. Operation is not dependent upon conductivity, pH, temperature, pressure or density of the liquid being monitored. Installed in the wall of a container, the device operates a relay when liquid rises to its level and changes the impedance of the sensing probe. Power requirement is only about 20 milliwatts in the normal, unloaded condition, and 100 milliwatts when the sensor is immersed and the relay is operating. The manufacturer offers a complete description and operating specifications.

◆ ◆ ◆

Designed to speed testing procedures, the new I-R Moisture-Matic balance automatically weighs the sample after each test and shows the moisture value directly in percentage on a counting device. A motor-driven torsion balance, the I-R Moisture-Matic is designed around a far-infrared heating element that gives highest heat absorption and rapid, even heating. It can be used with any material that can safely be dried by heat. Features of the instrument include a self-contained timer and a heat control variable between 30 and 600 watts. The operator need only load the pan and set the timer; no watching is necessary. The direct reading in moisture percentage is retained until the counter is reset. Information on the I-R Moisture-Matic can be obtained from Scientific Products Div., American Hospital Supply Corp., Evanston, Ill.

◆ ◆ ◆

Sterwin Chemicals, Inc., has made available two products—isoascorbic acid and sodium isoascorbate—for use in processing meat. Both are being offered at

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FRIES & FRIES

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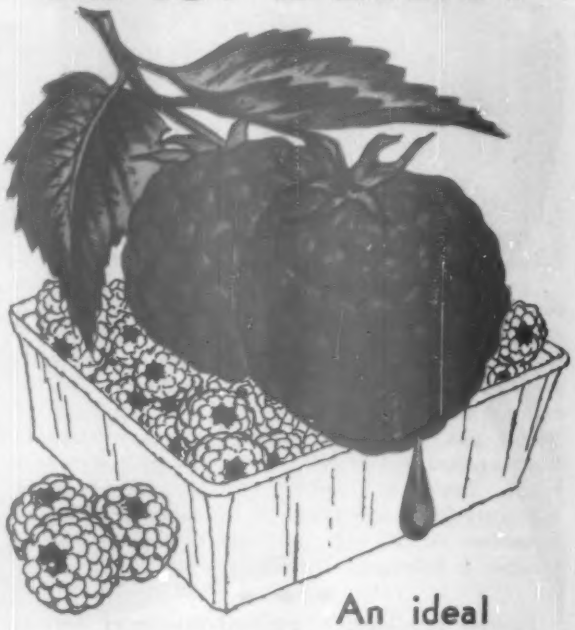

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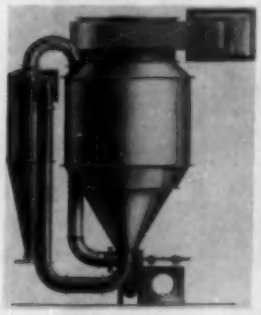
savings of up to 31 per cent over ascorbic acid and sodium ascorbate, according to the company. Details can be obtained from the manufacturer, at 1450 Broadway, New York 18.

◆ ◆ ◆

New pilot plant and semi-works spray dryers, offered by Proctor & Schwartz, Inc., are said to offer a versatility previously available only in custom-built equipment. The basic dryers are suitable for studies of spray drying problems and for small production runs on ordinary products. Modifications, made in the owner's plant, can adapt the basic units for use with viscous materials, for the production of hollow spheres or thin-walled "beads" or for conversion to a "dispersion" dryer. Evaporation rates of the basic units are 15-75 and 30-150 lbs. of water per hour; with the "dispersion" dryers, rates are increased to 200 and 400 lbs. per hour. All parts exposed to the product are Type 304 stainless steel. Steam, gas, or electric heating units are available, and standard motors and structural supports are provided. Two fluid atomizers normally are furnished, but centrifugal atomizers can be supplied. Full information on the new units can be had by writing Proctor & Schwartz, Inc., Philadelphia 20.



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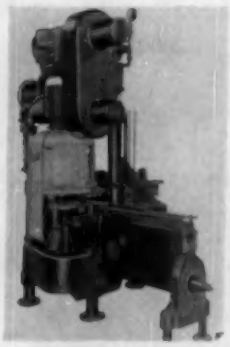
Packers interested in reduced machinery expense as well as quality performance are offered a new, six-spindle closing machine that is said to combine both qualities. Called the 450-HCM, the machine is rated at speeds up to 600 cans per minute, depending on can size and type of product; it will handle can sizes from 202 to 404 diameter and from 200 to 708 high. The new model is capable of closing all products except beer and carbonated beverages. The basic 450-HCM machine consists of a main drive, can feed table, filler floor stand, basic end marking unit, 90° discharge, including idler sprocket, and basic change parts for one can size. Auxiliary equipment is available for special applications. The 450-HCM is made by Continental Can Co., which offers full information and specifications. Write the company at 100 E. 42nd St., New York 17.



◆ ◆ ◆

A new imitation coffee flavor, Felcafe 89, said to be of remarkable fidelity and great potency and stability has been introduced by Felton Chemical Co. The company says that Felcafe 89 already has proven itself a valuable flavoring in hard candy, cream confections, dessert mixes, ice cream and beverages. The new product is available in various concentrations for easiest application. Samples and recommended uses can be obtained from Felton Chemical Co., 599 Johnson Ave., Brooklyn 37, N. Y.

◆ ◆ ◆

"Accel," a dry lactic acid starter culture for use in production of dry sausage, now is commercially available. Originally developed by the American Meat Institute Foundation, the new starter culture was put into production by the chemical division of Merck & Co., Rahway, N. J., in coöperation with the Foundation. The product is a formulation of the microörganism *Pediococcus cerevisiae*, which converts dextrose to lactic acid. Use of Accel in freshly-ground sausage is said to insure rapid production of uniform quantities of lactic acid and to reduce processing time as much as 60%.

◆ ◆ ◆

Based on a novel application of Ampere's Law, a new type of microbalance is said to be so unaffected by shock, vibration and temperature change that it can be carried about as needed, and operated on any bench or desk with ease. In the new instrument, called the Cahn Electrobalance, the sample weight is balanced by torque applied by an electric current in a magnetic field. Because the balance beam is always returned to the same position, torque is exactly proportional to current. The instrument is said to equal or exceed other laboratory microbalances in sensitivity and accuracy. Four ranges cover sample weights up to 50 mg. Precision is 0.02% and accuracy is 0.05% of full scale on all ranges. For further information, write Cahn Instrument Co., 7712 Danvers St., Downey, Calif.

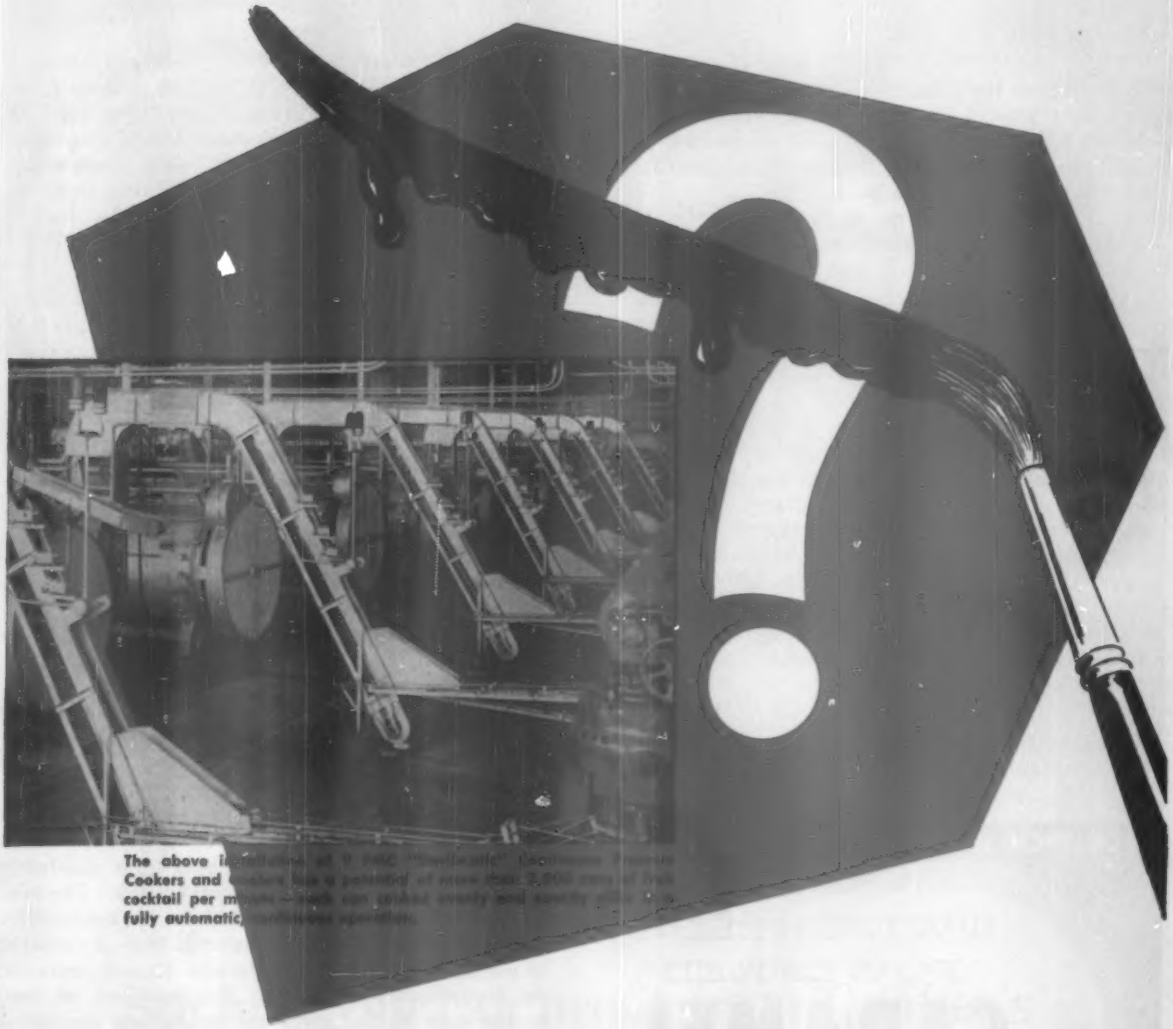
◆ ◆ ◆

Price Changes: Substantial reductions in the price schedule of methyl chavicol were announced recently by the Southern Chemical Div. of The Glidden Co. An important constituent of several natural essential oils, methyl chavicol, also known as estragole, is used principally for compounding odors and flavors. Technical information is available from The Glidden Co., Southern Chemical Div., P. O. Box 389, Jacksonville 1, Fla.

Nepera Chemical Co., Yonkers 2, N. Y., has reduced the price of niacinamide, bringing it more in line with the cost of niacin. The reduction is said to reflect Nepera's savings through process improvements and increased production.

Du Pont Co. has announced an increase of three cent per pound in the price of cellophane. The

(Continued on page 50)



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(Continued from page 48)

company noted that, including the present increase, it has been possible to hold the rise in cellophane prices to 53% over the low of 1939, while raw material costs have risen 123% and wage rates have risen 182% in the same period.

◆ ◆ ◆

A new thermal conductivity cell offered by Barnes Engineering Co. is said to extend appreciably the effective operating range of chromatographic analyses. Called Model 75, the new cell is designed to operate over a range of 30° to 325° C., and will accommodate liquids with boiling points up to 475° C. This is virtually the upper operating limit of chromatography, because beyond this point organic molecules begin to break down. The company claims that exceptional stability and sensitivity are achieved for the first time at these high temperatures through the use of flake thermistors as the sensing elements. The new Barnes cell consists of three units: the detector proper, the temperature controller, and the bridge circuit and power supply. The cell may be incorporated into any existing chromatographic apparatus. Complete details are available from Barnes Engineering Co., Stamford, Conn.

◆ ◆ ◆

Beckman Instruments, Inc., has introduced a completely transistorized d.c. amplifier, Model WN, for applications calling for high accuracy and absolute reliability in data handling equipment used in process control. Model WN actually is a "package" of four separate amplifiers, each contributing to precise amplification of the input signal. Full construction and operating specifications can be obtained from the Data & Control Systems Dept., Beckman Instruments, Inc., 325 N. Muller Ave., Anaheim, Calif.

◆ ◆ ◆

A new line of Teflon expansion joints and couplings is being offered for use where vibration, misalignment or temperature differentials cause trouble in glass, stainless steel, or glass-lined piping systems. The new line of fittings features field-replaceable bellows that can be removed easily, on the job, for cleaning, inspection, or replacement. Called Teflex, the new bellows utilize the heat- and chemical-resistant qualities of Teflon, and will not impart any taste, odor or color even when used under high temperatures, according to the manufacturer. Rated temperatures and pressures are 50 p.s.i. at 70° F., 34 p.s.i. at 150°, and 25 p.s.i. at 200°. At lower pressures, the units can be used at temperatures up to 250° F. Both the bellows and expansion joint assemblies are available for all pipe sizes up to 6-in. Special sizes also can be supplied. The manufacturer is Chicago Gasket Co., 1271 W. North Ave., Chicago, 22.

◆ ◆ ◆

For laboratory or plant jobs requiring vacuum flasks, new, safer flasks now are available. Called Insul-Steel containers, they are said to be absolutely implosion-proof and virtually unbreakable. The containers utilize a new development in lightweight, rigid, closed-cell plastic, a material that is resistant to acids, alkalies and all common organic solvents; the manufacturer says that this material, as used in the new flasks, gives the containers insulating qualities superior to those of an ordinary vacuum flask. Insul-Steel containers are available in capacities of 2, 4, and 8 liters, and complete information on them can be obtained from E. Machlett & Son, 220 E. 23rd St., New York 10.

◆ ◆ ◆

The time needed for mixing to panning bread dough is reduced from several hours to about two minutes with the new Do-Maker process recently announced by Baker Process Co., a division of Wallace & Tiernan, Inc. Do-Maker consists of a technique and equipment to measure and feed prefermented yeast solution, oxidant solution, melted shortening and flour to a continuous pre-mixer. Dough is pumped continuously from the pre-mixer into a developer, where it is extruded into a divider that cuts the dough pieces accurately and drops them into baking pans on a synchronized panner. All phases of the process are controlled and can be preset from a central control panel, and the entire operation can be handled by two men. According to the manufacturer, the equipment requires only a third to a quarter of the space needed for the con-

(Continued on page 52)

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QUAKER

THE QUAKER OATS COMPANY
CHICAGO 54, ILLINOIS

(Continued from page 50)

ventional sponge-dough operation. Additional savings are claimed through improved sanitation, the elimination of much conventional equipment, and the elimination of many manual operations. Initial test installations, all said to have proved successful, have been made in several parts of the country. Complete information on the Do-Maker is available from Baker Process Co., 30 Main St., Belleville 9, N. J.

◆ ◆ ◆

Walworth Co., 60 E. 42nd St., New York 17, has introduced what it calls the first all-plastic Y-globe valve with full flow passage. Made of rigid polyvinyl chloride, the new PVC valve is designed to control alkalis, acids, inorganic salt solutions and other corrosive fluids. Non-toxic as well as non-corroding, the valve will operate at pressures up to 150 p.s.i. at 75° F. The model currently available is for 1-in. pipe: other sizes, from ½-in. to 2-in., will be available soon.

◆ ◆ ◆

Appearing before IFT's Chicago Section, Frank N. Rawlings, research director of Amalgamated Sugar Co., Ogden, Utah, displays a new device to aid marketing of sugar. Called the Liquilizer, it bolts onto bottom of railroad hopper car, makes bulk beet sugar into liquid, automatically maintains proper strength of solution. By receiving and converting dry sugar, consumer saves cost of shipping water, ordinarily constituting about one-third of liquid sugar. Amalgamated plans to make Liquilizer available to other sugar companies under licensing agreement.

◆ ◆ ◆

To save time in reading temperatures and pressures, Dickson Company has provided its standard Minicorder with an indicating scale and pointer large enough to be seen from a distance. The new instrument, known as the Mindicorder, has the indicator scale mounted above the recording chart; a fluorescent pointer indicates the temperature or pressure being recorded, making it unnecessary for the operator to step close enough to read the chart. The scale pointer and recording pen are always in synchronization, since both are linked to the same measuring element. Mindicorder units are available in some 100 different chart ranges, for temperatures from —200° to 1,000° F., and for pressures up to 2,000 p.s.i.g. Dickson Company, 7422 Woodlawn Ave., Chicago 19, offers complete specifications for the new instruments.

◆ ◆ ◆

Glengarry Processes, Inc., has added to its line of weighing equipment an automatic unit with two operating heads, offering twice the speed of single-station models. The new unit, really two machines in one, is said to be capable of weighing a wide variety of dry products over a range adjustable from 1 oz. to 5 lbs. at speeds up to 40 per minute. For special applications, it can handle two different materials simultaneously. Its compactness is said to make the unit an ideal accessory to high-speed bag making machines in applications that call for net-weight filling. An automatic feed mechanism is available for converting the new dual-station model into a fully automatic filling machine. Complete information can be obtained from Glengarry Processes, Inc., Bay Shore, N. Y.

◆ ◆ ◆

Three instruments designed to further automation are available for patent licensing from Carbon & Carbide Chemicals Co., 30 E. 42nd St., New York 17. The three instruments, all designed for automatic measurement of streams of liquids and gases in production processes, are a chromatographic analyzer, a differential refractometer, and an electrolytic concentration cell. Carbide has been using all three in its own plants, and now will license instrument makers to produce and sell them to industry.

◆ ◆ ◆

A "kraut-cutting" bee, held recently in Cleveland, has resulted in the first official grading of kraut for the commercial market. The kraut-cutting bee, and the new standards, were the culmination of a six-year research program supervised by Dr. Carl S. Pederson, scientist at the New York State Agricultural Experiment Station and IFT member. Dr. Pederson worked with a research committee of the National Kraut Packers Association and representatives of the U. S. Department of Agriculture to select the five chief grading factors. These will include tests for flavor, cut character, color, and defects. Henceforth, kraut will be marketed as Fancy, Extra Standard, and Standard.

◆ ◆ ◆

The Zeromatic pH meter, a new development of Beckman Instruments, Inc., is an automatic push-button instrument that can be adapted for potentiometer recorder output, automatic temperature compensation, and Karl Fischer titrations. The line-operated instrument features automatic correction for electronic zero drift. Zeromatic has a 0-14 pH scale range and two millivolt ranges: 700-0-700 mv. and an extended 0-1,400 mv. range that is especially useful for oxidation-reduction titrations. Any point on the 0-1,400 scale can be set as zero. In operation, Zeromatic is connected to the 115-v. power source at all times, on "Standby." To make a pH reading, the "Read" button is depressed. Push-buttons also control temperature compensation ("Manual" or "Automatic") and selection of the appropriate millivolt range. Bulletin 705, describing the Zeromatic pH

(Continued on page 60)

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"Guess we should check with them on Product Development, Eye-Appeal, New Product Suggestions, too. We've known the Stange name for years so—like they suggest—perhaps we'd...better check with Stange and be sure."

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SELECTED ABSTRACTS . . .

Compiled by H. A. Campbell

ANALYTICAL METHODS

Use of plastic tubing in chromatography.
VEVERS, H. G., AND MILLOTT, N. (Reagent's Park, London, N. W. 1). *Nature, 178,* 1132 (1956).

Plastic tubing as a chromatographic column has the advantage of being able to isolate zones easily and quickly by cutting the column with a razor.

A rapid method for estimating total protein in milk.
UDY, D. C. (U.S.D.A., Pullman, Washington). *Nature, 178,* 314-15 (1956).

The binding capacity of milk proteins for the anionic dye, orange G, has been correlated to protein values (N X 6.38) and serves as the basis for a rapid method for estg. total protein in milk.

Method for the quantitative determination of citral.
TROITSKAYA, N. A. (Crimean Med. Inst.). *Aptechnoe Delo., 5* (1), 16-19 (1956); *Anal. Abstr., 3,* No. 3673 (1956).

A colorimetric detn. of citral is based on its reaction with benzidine in glacial AcOH or EtOH to give a yellow red product having an absorption max. at 350 mμ.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

The biosynthesis of milk-fat in the intact cow.
ROGERS, T. A., AND KLEIBER, M. (Univ. of California, Davis). *Biochim. et Biophys. Acta, 22,* 284-92 (1956).

The behavior of the principal metabolites of the cow as precursors of milk-fat has been studied. Glucose is important in fat synthesis as a precursor of glycerol, but fatty acid synthesis from glucose is on a very small scale. Acetate is the most potent precursor of fatty acids, but it is also a source of glycerol. Propionate is unimportant in fatty acid synthesis, but the activity of glycerol following the injection of labelled propionate supports the view that propionate is the main carbohydrate precursor in the cow. Butyrate shows intermediate lipogenic and glycogenic functions. Formate is not a source of fatty acids in milk-fat, but does contribute some C to glycerol. The peak radio-activity in all of the fat-constituents was observed in the second milk-samples (taken at 11 hrs.), whereas for the casein and lactose it was in the first (3 hrs. after injection of the tracer).

The metabolism of butylated hydroxyanisole in the rabbit.
DACRE, J. C., DENZ, F. A., AND KENNEDY, T. H. (Univ. of Otago, Dunedin, New Zealand). *Biochem. J., 64,* 777-82 (1956).

After 1 g. of BHA by mouth, rabbits excreted 46% as glucuronides, 9% as ethereal sulfates and 6% as free phenols. The recovery of glucuronide was 60% of a 0.5 g. dose, and 84% of a 0.25 g. dose. After repeated doses of 1 and 0.5 g., recovery of BHA as glucuronide was lower than after single doses. The glucuronides of the two BHA isomers have been isolated from the urine as Ba (2-*tert*-butyl-4-methoxyphenyl glucosid) uronate and Ba (3-*tert*-butyl-4-methoxyphenyl glucosid)-uronate. BHA is unstable on heating in 5*N*-HCl and breaks down to *tert*-butyl-quinol, *p*-methoxyphenol and quinol.

Chemical aspects of enzyme inhibition.
SIZER, I. W. (Mass. Inst. of Technology, Cambridge). *Science, 125,* 54-9 (1957).

The use of chem. reagents as enzyme inhibitors has yielded information concerning the mechanism of inhibition and the role in catalysis played by active groups on the protein apoenzyme, the coenzyme, or the metal component. Inhibition analysis has also furnished valuable clues concerning the architecture, chem. properties and catalytic mechanism of the active site of the enzyme. In many cases, *in vivo* effects of inhibitors can be closely correlated with *in vitro* inhibition of purified enzyme systems.

Essential amino acid content of farm feeds.
LYMAN, C. M., KUIKEN, K. A., AND HALE, F. (Mechanical Coll. System, College Sta., Texas). *J. Agr. Food Chem., 4,* 1008-13 (1956).

The essential amino acid content of the following materials is given; algae, animal by-products, fermentation feeds, fish by-products, grains, grain by-products from milling and processing, oilseed meals and residues, peas, beans and alfalfa meal.

The structure of insulin.
SANGER, F., AND SMITH, L. F. *Endeavour, 16,* 48-53 (1957).

The result demonstrates that insulin, and probably other proteins, are homogeneous substances with unique structures and are not merely statistically random polymers of amino acids.

Modifying and protective factors in inactivation of prostatic acid phosphatase by high voltage beta-rays.
STECKERL, F., AND GREANEY, J. F. (Boston Univ. Sch. of Med., Mass.). *Biochim. et. Biophys. Acta, 22,* 304-13 (1956).

The inactivation of dil. solns. of prostatic acid phosphatase was found to be altered by (1) the protein environment of the enzyme during irradiation; the concn. of these proteins as well as their configurational properties play an important role in this respect. (2) The nature and concns. of the amino acids present in the enzyme soln. exposed to β-radiation also exerted a modifying influence on the degree of the inactivation of the acid phosphatase. The amino acids apparently divert the energy of irradiation from the enzyme by undergoing a condensation polymerization.

MICROBIOLOGY

Thermal resistance of food poisoning organisms in poultry stuffing.
WEBSTER, R. C., AND ESSELEN, W. B. (Univ. of Massachusetts, Amherst). *J. Milk and Food Technol., 19,* 209-12 (1956).

Thermal death times of food poisoning types of organisms as represented by *Salmonella enteritidis, Micrococcus pyogenes* var. *aureus,* and *Streptococcus faecalis* in poultry stuffing were investigated. The thermal destruction characteristics of these organisms are described in terms of z and F_{135} values. *Streptococcus faecalis* was considerably more heat resistant than the other two organisms studied. The data obtained indicate that roasting procedures for stuffed poultry, based on the attainment of a center stuffing temp. of 165° F., should be adequate to destroy such organisms if present in the stuffing.

NUTRITION

Tryptophan-niacin relationships in man. Studies with diets deficient in riboflavin and niacin, together with observations on the excretion of nitrogen and niacin metabolites.
HORWITT, M. K., HARVEY, C. C., ROTHWELL, W. S., CUTLER, J. L., AND HAFFRON, D. (Elgin State Hospital, Ill.). *J. Nutrition, 60,* 1-43 (1956). suppl.

Controlled feeding of a diet which provided only 5.8 mg. of niacin and 265 mg. of tryptophan per 2300 cals. to 15 subjects for from 38 to 87 weeks produced no clinical evidence of pellagra. Comparisons of the levels of N methylnicotinamide excreted at different levels of niacin and tryptophan intake showed that approx. 60 mg. of tryptophan are equiv. to 1 mg. of niacin. Data pertaining to the possibility that lysine or methionine added as supplements may inhibit the formation of niacin metabolites are presented and discussed. The level of excretion of N methylnicotinamide has been confirmed as an indicator of the ability of the organism to ext. niacin derivs. from the diet and in this manner may prove to be a useful index of niacin-tryptophan availability.

The effect of pyridoxin deficiency on certain organs of the rat.
COMBRIDGE, C. D. (Queen Elizabeth Coll., Campden Hill Road, London). *Brit. J. Nutrition, 10,* 347-54 (1956).

Rats fed on a pyridoxin-deficient diet grew less and their thymus wts. were

(Continued on page 56)

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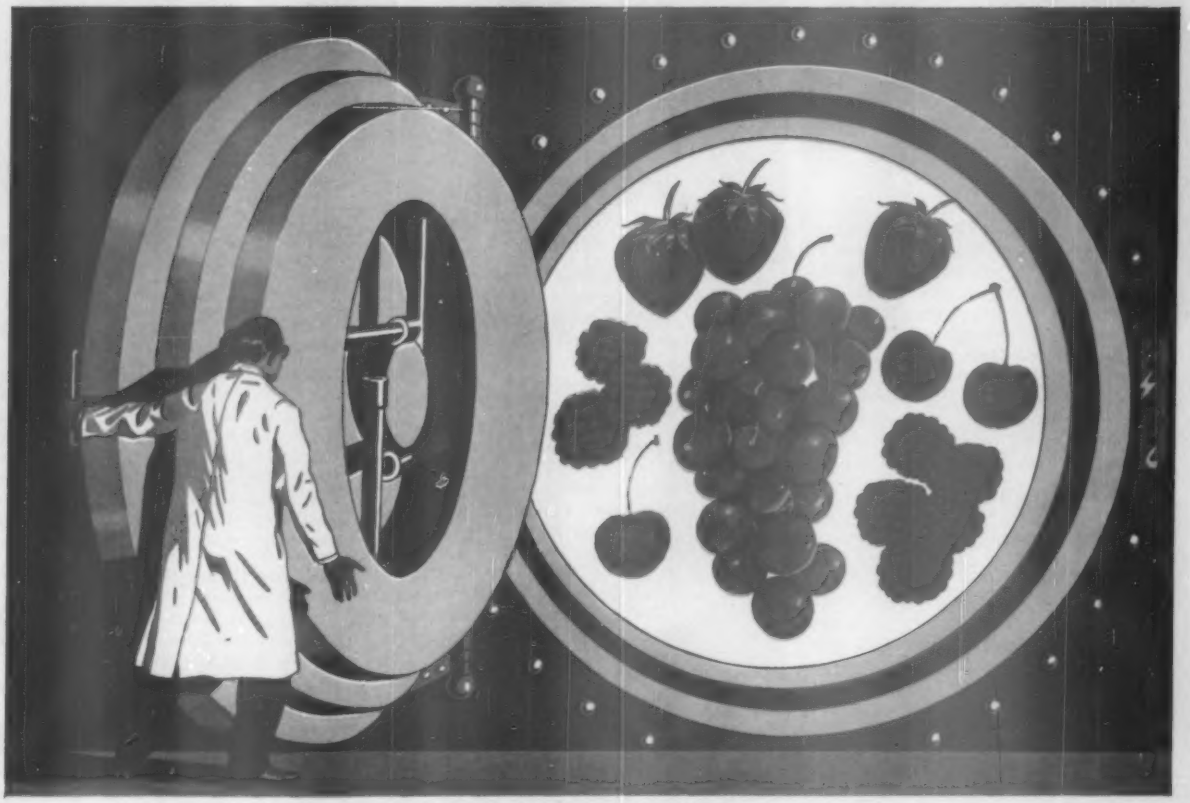

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(Continued from page 54)

lower and adrenal wts. higher, relative to body wt., than those of the controls. Histological changes in the adrenal and thymus glands preceded fatty infiltration of the centrilobular region of the liver in the deficient rats.

Vitamin C economy of rabbits.

HARRIS, L. J., CONSTABLE, B. J., HOWARD, A. N., AND LEADER, A. (Univ. of Cambridge and Med. Research Council, Engl.). *Brit. J. Nutrition, 10,* 373-82 (1956).

The findings showed that the rabbit can synthesize its own vitamin C and can also derive further supplies from any in the diet. In line with this interpretation was the finding that the concns. of ascorbic acid in the organs of the rabbit were of a similar order to those found in the rat and chick and appreciably higher than in those of guinea-pigs receiving reasonably liberal allowances of vitamin C. It was thus impossible to substantiate the descriptions in the earlier literature of the occurrence of scurvy in rabbits.

Significance of fats in nutrition.

DAM, H. (Univ. of Copenhagen, Denmark). *Fette, Seifen Anstrichmittel, 58,* 977-84 (1956).

Recent research on requirement of essential fatty acids and its dependence on various factors. Deficiency symptoms are studied in relation to growth, skin-damage and degeneration of various organs. Relation between fat- and cholesterol-metabolism, and significance of chain length of fatty acids, are discussed.

The role of fat in the diet of rats. 10. Influence on reproduction of hydrogenated arachis oil as the sole dietary fat.

AAES-JORGENSEN, E., FUNCH, J. P., AND DAM, H. (Polytechnic Inst., Copenhagen). *Brit. J. Nutrition, 10,* 317-24 (1956).

The paper deals with the reproductive capacity of rats of both sexes reared on a crude-casein diet contg. 14% hydrogenated arachis oil, so that it was relatively high in fat but low in essential fatty acids. The results show that the reproductive capacity of the female rats was severely impaired by feeding hydrogenated arachis oil for 15 wks. However, the normal mature males used as mating partners for these females were found to be normal both on autopsy and on histological examn. of their testes, kidneys, adrenals and liver.

Unsaturated fatty acids and serum cholesterol levels.

Nutrition Revs., 14, 327-8 (1956).

Studies indicate that large concns. of unsatd. vegetable oils included in formula feedings result in a decrease of serum cholesterol in a majority of individuals. However, except for a transient period, a similar reduction is not obtained if such fats are included in an ordinary diet to the extent that they provide 30 to 40% of the total caloric intake—a level that might be compatible with practicality.

Nutritional effects of lactose and galactose.

SCHEUNERT, A., AND SOMMER, H. *Biochem. Z., 327,* 461 (1956); *Fette, Seifen Anstrichmittel, 58,* 1009 (1956).

Importance of lactose in young animals depends on its effects on the intensive growth of the central nervous system.

Salicylate and carbohydrate metabolism.

SMITH, M. J. H., AND JEFFREY, S. W. (King's Coll. Hosp. Med. Sch., Denmark Hill, London). *Nature, 178,* 310 (1956).

Results are given to indicate that salicylate interferes with oxidative phosphorylation processes and inhibits the synthesis of high-energy phosphate bonds.

Low-sodium milk. Growth and consumption studies with rats.

SEIFRIT, E. (Reading, Pa.). *J. Am. Dietet. Assoc., 32,* 1167-9 (1956).

Three groups of rats were fed diets of whole milk, low Na milk, and Na-restored low Na milk for 10 weeks. Each diet was supplemented to make it adequate in minerals and vitamin D. Rats on a diet of low-Na milk exhibited a significantly lower growth rate and a significantly higher food intake per unit of body wt. than those on a whole milk diet of Na-restored low-Na milk diet. Rats on a diet of Na-restored low-Na milk exhibited growth and intake levels not significantly different from rats fed whole milk.

Iron-deficiency anemia in the pregnant woman and its relation to normal physiological changes.

HYTTEN, F. E., AND DUNCAN, D. L. (Univ. of Aberdeen, Scotland). *Nutrition Abstr. & Revs., 26,* 855-68 (1956).

In normal pregnancy the plasma vol. rises, on the av., by about 40% and the red cell mass by about 17%. The result is reduction of the red blood cell count to about 80 or 85% of the non-pregnant; the hemoglobin concn. and the packed cell vol. show a parallel decrease. The fall in hemoglobin concn. during pregnancy is often interpreted as an index of Fe deficiency because it can be reduced or prevented by giving addnl. Fe, but Fe in large doses appears to be a specific stimulus to blood formation, even in healthy non-pregnant persons. No advantage has been demonstrated from raising the hemoglobin level in normal pregnancy and there may be dangers. A high incidence of "low" hemoglobin levels has been taken as evidence of poor nutrition, but, in the United Kingdom at least, the av. diet provides more than enough Fe for the extra requirements of pregnancy.

A nutritional requirement for bromine.

HUFF, J. W., BOSSHARDT, D. K., MILLER, O. P., AND BARNES, R. H. (Merck, Sharpe and Dohme Research Labs., West Point, Pa.). *Proc. Soc. Exptl. Biol. and Med., 92,* 216-19 (1956); *Biol. Abstr., 31,* No. 650 (1957).

Addition of an iodinated casein with thyroid activity to a purified diet adequate in all known essential nutrients produced a growth retardation in mice. Growth inhibition was reversed by fractions of whey and by whey ash. The active inorg. component was found to be Br.

Daily nitrogen requirements of adult man.

Nutrition Revs., 14, 324-5 (1956).

Work done recently presents evidence that the N requirements of apparently well adults is lower than was previously thought. The calcd. daily protein requirement of 22 g. is considerably less than the value of 1 g./kg. of body wt. per day recommended by the Food and Nutrition board.

Nitrogen balances of women maintained on various levels of lysine.

JONES, E. M., BAUMAN, C. A., AND REYNOLDS, M. S. (Univ. of Wisconsin, Madison). *J. Nutrition, 60,* 549-62 (1956).

The effects of various levels of lysine intake on N balance were studied in 14 women maintained on a semisynthetic diet in which about 95% of the total N was furnished by pure amino acids and diammonium citrate. It appears that 0.40 to 0.50 g. lysine per day is adequate for the establishment of N balance in women under these conditions.

Dietary protein and the serum cholesterol level in man.

KEYS, A., AND ANDERSON, J. T. (Univ. of Minnesota, Minneapolis). *Am. J. Clin. Nutrition, 5,* 29-34 (1957).

The authors conclude that the results in the present study do not afford confirmation to the suggestion that the low cholesterol values in populations living on low fat intakes are in any way related to the amt. or kind of protein in their diets. Actually, the idea that dietary protein may influence the serum cholesterol level is supported only by animal expts. that seem to have little relevance to the situation in man.

Isohemagglutinins and immunity in malnutrition.

KAHN, E., STEIN, H., AND ZOUTENDYK, A. (Baragwanath Hosp., Johannesburg). *Am. J. Clin. Nutrition, 5,* 70-1 (1957).

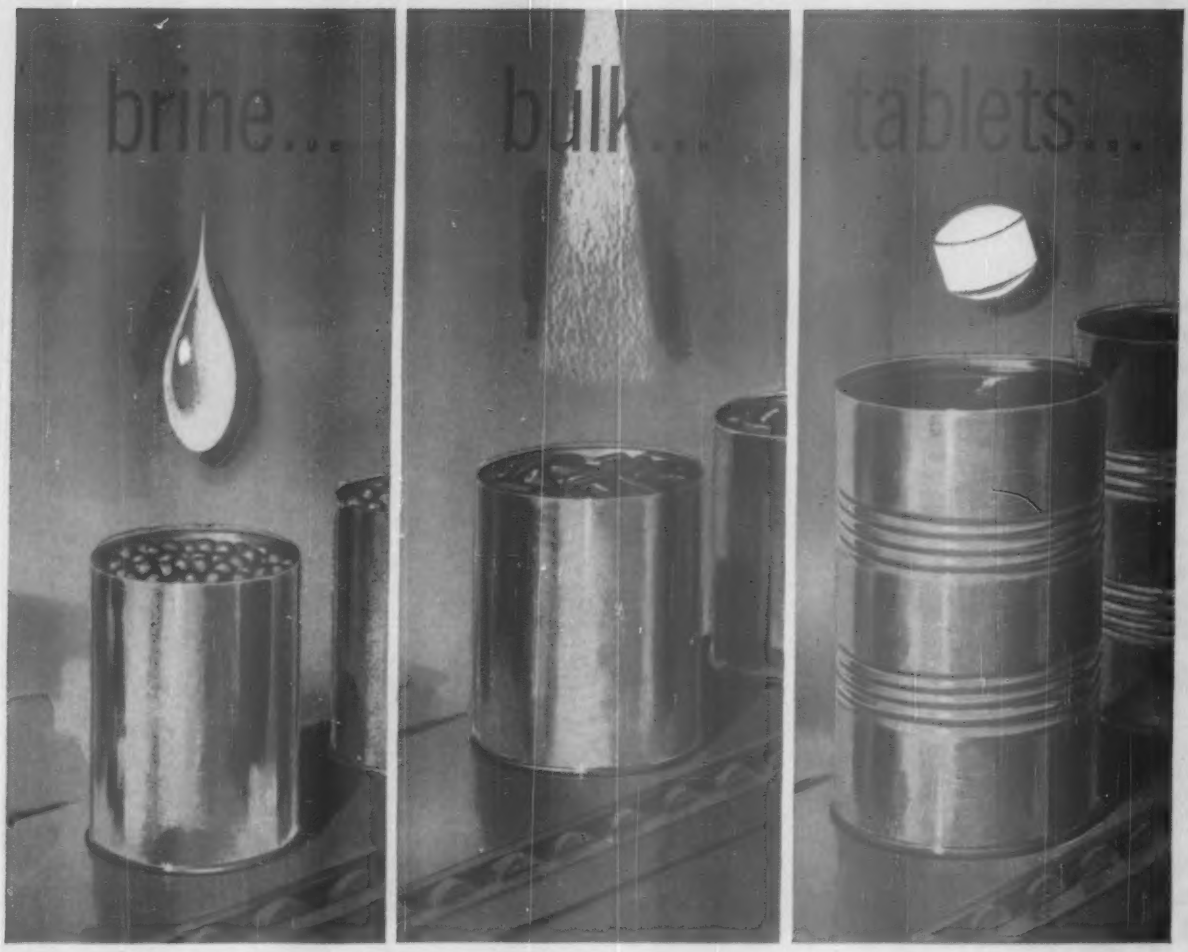
Malnourished children appear to have a poor resistance to infection. In order to det. whether this is due to impaired antibody production, the isohemagglutinin titers of 14 severely malnourished children were examd. These titers were within normal limits. This seems to confirm findings of other authors, that in man, unlike lab. animals, malnutrition does not impair immune-body production.

Formulation of efficient poultry rations.

COMBS, G. F. (Univ. of Maryland, College Park). *Feedstuffs, 29* (3), 48-51 (1957).

Suggests nutrient levels for poultry and discusses the calorie-protein ratio and its effects. Useful tables are given for calcns. (in dollars) of "partial nutritional worth", "value of crude protein"

(Continued on page 58)



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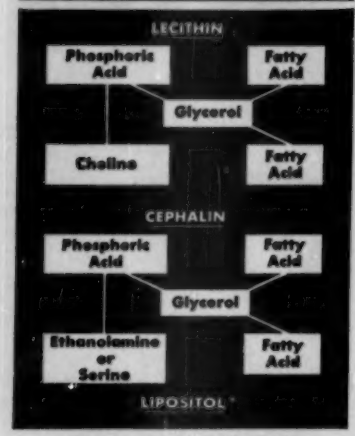

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A. E. Staley Mfg. Co., Decatur, Ill.

(Continued from page 56)

and "value of productive energy" of various feedstuffs.

The effects of chronic undernutrition and of total starvation on growing and adult rats.

WIDDOWSON, E. M., AND MCCANCE, R. A. (Univ. of Cambridge, Engl.). *Brit. J. Nutrition, 10,* 363-73 (1956).

Groups of adult and young male and female rats were subjected to chronic undernutrition, or to full nutrition and then to starvation for 6 days, and killed when their wts. were about the same. Undernutrition, and full nutrition followed by starvation, produced in general closely similar changes in the compn. of the bodies and organs, but age made a difference in the effects, and sometimes did sex.

Experimental dental caries in the albino rat. The production of carious lesions in animals maintained on a finely powdered purified diet containing 67% sucrose.

HARPLES, R. L., LAWTON, F. E., AND SLACK, G. L. (Univ. of Liverpool). *Brit. J. Nutrition, 10,* 234-40 (1956).

Animals maintained on a high sugar (67%) diet did not develop any measurable dental caries until they were 149 days old. At 184 days of age there was a considerable increase in caries, the av. no. of affected teeth per animal rising to 2.2. It would appear, therefore, that in the conditions of this investigation the rats must be maintained on a high sugar diet until they are about 6 months old before a degree of caries adequate for exptl. purposes is produced. The results emphasized the dangers of comparing findings of different labs. since small changes in the diet or a change in environment may influence the susceptibility to dental caries.

Analysis of body composition.
Nutrition Revs., 14, 331-2 (1956).

Evidence seems to indicate that chronic K depletion may be seen to lead to an inability to handle salt loads, as well as to interference with renal tubular function as it concerns H_2O conservation.

PHYSIOLOGY AND MEDICINE

Amino acid solutions for intravenous use. The reduced incidence of systemic reactions when using a low glutamic acid mixture.

RICE, C. O., AND STRICKLER, J. H. (Univ. of Minnesota, Minneapolis). *Am. J. Clin. Nutrition, 5,* 11-13 (1957).

The data show that a mixt. of amino acids for parenteral use with a low glutamic acid content causes much less nausea and fewer undesirable clinical symptoms than have been observed with a soln. essentially identical except for a high glutamic acid content.

Methionine toxicity in liver disease.
Nutrition Revs., 14, 336-7 (1956).

Investigation suggests that bacterial action on methionine may lead to the production of toxic substances in patients suffering from liver disease. These toxic substances cause neurologic disorders.

Metabolic alterations in surgical patients. IX. The influence of intravenously administered fat emulsions on nitrogen balance in post-operative patients.

LEVEY, S., KRIEGER, H., BENSON, J. W., DAVIS, J. H., AND ABBOTT, W. E. (Univ. Hospitals of Cleveland). *J. Lab. Clin. Med., 49,* 61-8 (1957).

The effect of intravenously administered fat in decreasing the N deficit of post-operative patients is believed not to be a special attribute of the fat but rather to be due to the addnl. caloric supplementation. The intravenously administered fat emulsion increased the caloric intake in these patients, who received adequate amts. of N and moderate amts. of cals., in the form of hexose, to such an extent that there was improved utilization of the protein hydrolyzate, which resulted in a decreased N deficit.

ENGINEERING AND PLANT EQUIPMENT

Efficiencies of mixing tanks in smoothing concentration fluctuations.

GUTOFF, E. B. (Brown Co., Berlin, N. H.) *Ind. Eng. Chem., 48,* 1817-18 (1956).

In many chem. processes automatic controllers are used to maintain desired concns. These controllers may introduce small cyclic fluctuations in concns. which can be undesirable. In such cases, a mixing tank should be considered to smooth out these fluctuations. Relationship is developed which gives max. outflow concn. variation to max. input variation.

Electronics control coffee roasting.
Food Manuf., 31, 505-7 (1956).

A new factory in London is described, main feature of which is a German-made electronically-controlled coffee roasting plant.

FOOD AND FOOD TECHNOLOGY

BAKING AND BAKERY PRODUCTS

Lines of attack on dough chemistry.

HLYNKA, I., AND ANDERSON, J. A. (Grain Commissioners for Canada, Winnipeg, Man., Canada). *J. Agr. Food Chem., 5,* 56-9 (1957).

New developments in dough rheology include description of dough properties by means of structural relaxation curves and relaxation time spectra. Amperometric titrations and polarographic studies are among the recent analytical tools. Dough is currently treated as a dynamic cross-linked polymer network in which protein plays a major role; but a detailed explanation of dough structure, consistent with all data obtained by all methods, has yet to be developed.

FATS AND OILS

Antioxidant properties of tomato lipids.

HENZE, R. E., AND QUACKENBUSH, F. W. (Purdue Univ., Lafayette, Indiana). *J. Am. Oil Chemists' Soc., 34,* 1-4 (1957).

Highly active antioxidants can be extd. from dried tomato fruits with petroleum

ether, and will protect fresh lard against autoxidation at 100° C. for long periods. The antioxidant activity of tomato lipids can be sepd. into 2 fractions, one consisting of a primary antioxidant and the other of a synergistic (potentiating) substance.

MEAT AND FISH

The phospholipids of fish.

LOVERN, J. A. (Torry Research Sta., Aberdeen, Scotland). *J. Sci. Food Agr., 7,* 729-33 (1956).

Detailed studies have been made of the phospholipids of the flesh of cod and haddock. The component phospholipids of this tissue show a general similarity in the two species. A complex mixt. of phospholipids is present, in which lecithins predominate (50-60% of the total phospholipids). There is also a group of 3 unidentified phospholipids. Two of these lipids may be derivs. of a bis-phosphatidic acid. Three types of inositol phosphatide have been detected. Phosphatidylethanolamine is a minor component, there are traces of plasmalogens, sphingomyelin is doubtful, and phosphatidyl-serine is absent.

Use of antibiotics for the preservation of fish and sea foods.

BOYD, J. W., BLUHM, H. M., MUIRHEAD, C. R., AND TARR, H. L. A. (Fisheries Research Board of Canada. Vancouver). *Am. J. Public Health, 46,* 1531-9 (1956).

The successful use of ice contg. chlortetracycline (CTC) in preserving salt water fish while in transit to markets is reported.

POTATOES

Studies on the storage stability of C-vitamin in potato granules at various moisture levels.

KISSMEYER-NIELSEN, E. (Potato Starch & Granule Factory, Olsted, Denmark). *Am. Potato J., 33,* 353-4 (1956).

The C-vitamin content of potato granules is more stable in samples of lower moisture content than those with higher moisture.

STARCHES

Relationship of age with strain retardation in a starch gel.

STERLING, C. (Univ. of California, Davis). *Food Research, 21,* 680-8 (1956).

Creep and recovery measurements were made on a starch gel at different ages and with varying loads. The modulus of elasticity and coeff. of "viscosity" increased with gel age, while total strain attained and rate of retardation of strain decreased. Resilience of the gel increased as time of aging increased. Since little moisture loss occurred in storage, the above effects indicated an intrinsic retrogradation of the polysaccharide mols. i.e. increased parallel assocn. at micellar junction points, to strengthen the network in the gel.

PACKAGING

The molten bead sealer.

CHINN, H. G. (Union Carbide & Carbon Corp.). *Modern Packaging, 30* (4), 153-6 (1956).

A look into the versatile abilities of Takamine Enzymes will help in the final analysis of your products at the market-place.

If you are plagued with processing or stability problems involving starches, pectins, proteins, glucose (browning reaction) or oxidative changes, Takamine Enzymes will speed operations, control viscosity, enhance flavor and taste and improve storage stability.

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PROTEINASES
for the modification and hydrolysis of proteins in food manufacturing and pharmaceutical operations.

PECTIC ENZYMES
for the hydrolysis of pectins in fruit and fruit juices to speed processing and to make fruit juices sparkling clear for consumer appeal.

TAKAMINE

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A report of a recent development by the Bakelite Co. concerning a new principle of sealing polyethylene film, paper, polyethylene coated paper, polyethylene laminates as well as other thermoplastic films or combinations. Basically, the operation consists of extruding a hot filament of polyethylene between two layers of film instead of attempting to drive heat through one of the layers.

Bond tester for coatings.

GUILLOTTE, J. E., AND MACDERMOTT, C. P. (E. I. du Pont de Nemours & Co. Inc., Wilmington, Del.). *Modern Packaging, 30* (4), 157-60 (1956).

An evaluation of the Perkins-Southwick instrument indicating that it will measure quantitatively and reproducibly the adhesion of polyethylene.

Cathode-ray irradiation of cellophanes.

KAREL, M., AND PROCTOR, B. E. (Massachusetts Inst. of Technol., Cambridge). *Modern Packaging, 30* (5), 141-8+ (1957).

A report on an investigation to obtain further information on the effect of irradiation on moisture proof cellophanes. Results of this study indicate that the conventional types of moisture proof cellophane may have to be modified if they are to be used for the packaging of high moisture content foods processed by irradiation.

PHYSICAL RESEARCH

Acidity of catalyst surfaces. 1. Acid strength from colors of adsorbed indicators.

BENESI, H. A. (Shell Development Co., Emeryville, Calif.). *J. Am. Chem. Soc., 78,* 5490-4 (1956).

Acid strength of catalyst surfaces have been measured by noting the colors of adsorbed Hammett indicators. It has been found, for example that: dried clays and cracking catalysts are still strongly acid after they have been "neutralized" with aq. NaOH soln.; unused silica-alumina catalysts appear to be at least as strongly acid as 90% H_2SO_4; silica-magnesia catalysts are weaker acids than silica-alumina catalysts.

RADIOCHEMICAL TECHNOLOGY

An enhancement of catalytic acitivity by gamma radiation.

TAYLOR, E. H., AND KOHN, H. W. (Oak Ridge Natl. Lab., Oak Ridge, Tenn.). *J. Am. Chem. Soc., 79,* 252-3 (1957).

Evidence is presented for the production by γ rays of a marked increase in catalytic activity of Al_2O_3.

PATENTS

Sausage meat.

Brit. 754,406, August 8, 1956.

Trisodium pyrophosphate or its hydrate, Kurrol's salt (K metaphosphate) or other condensed alkali metal phosphates are incorporated in sausage meat to cause swelling and softening of the muscle fibers giving more uniform fat distribution. Pickling agents such as nitrates, nitrites, NaCl, glucose or other carbohydrates, or other agents with a negative heat of soln. are also incorporated.

FOOD INDUSTRY TOPICS

(Continued from page 52)

meter, is available from the Scientific Instruments Division, Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

◆ ◆ ◆

Candy manufacturers now can get a new line of reinforced plastic trays developed especially for drying, handling, and transporting candy centers before dipping. Called Toteline tray Model 519, the new design features sides that drop 1¼ in. along the long dimension to permit air circulation over the contents. The trays lock one atop another and are easy to move in stacks. Made from fiber glass and polyester resins, the new trays can be steam-cleaned, cannot warp, bend or dent, and are stronger than steel on a strength-weight basis, according to the manufacturer. Tray No. 519 measures 30⅜ by 15⅞ by 2¼ in. Details and prices can be obtained from Fiber Glass Tray Co., Linesville, Pa.

◆ ◆ ◆

New features for its impact-in-air comminutor have been announced by the Cog Corp. "Snap-apart" construction makes it possible to clean all working parts quickly and thoroughly, and the rotor is reversible on its splined shaft to permit the use of dual-purpose blades or to give extra blade life. Over-all construction is based on subassemblies that need minimum maintenance, provide maximum accessibility, and offer a variety of combinations in one basic unit. Variations in the standard model include units for size reduction of wet as well as dry products, spray-blending of dry and wet ingredients on a continuous basis while maintaining accurate formula ratio, and continuous and intensive blending of dry ingredients in any required ratio. Sizes range from 3 to 300 h.p. Operating details, suggested applications, and specifications can be obtained from the Cog Corp., 4441 W. Lake St., Chicago 24.

the literary corner . . .

Reprints of "Sweet Potato Processing: Pilot Scale Rotary Lye Peeler," which appeared in the November 1956 issue of *Food Technology,* are being offered free of charge by Southern Utilization Research & Development Div., 1100 Robt. E. Lee Blvd, New Orleans 19. The paper, by Jett C. Arthur, Jr., and T. A. McLemore, describes and illustrates construction of a simple peeling machine that uses a hot caustic solution. Data are also included on the effects of lye concentration, preheating, and other factors on peeling and trimming losses.

◆ ◆ ◆

The spring catalog of Magnus, Mabee & Reynard, Inc., in addition to more than 1,000 listings of essential oils, concentrated flavors, aromatic chemicals and certified colors, contains a products-by-industries classification of special interest to confectioners and makers of baked goods, foods, cosmetics and pharmaceuticals. Copies of the catalog are available to any manufacturer making quantity purchases. Write Magnus, Mabee & Reynard, Inc., 16 Desbrosses St., New York 13.

◆ ◆ ◆

A new and more convenient guide to determining the corrosion resistance of aluminum has been published by Reynolds Metals Co. Entitled "Corrosion Keys for Aluminum," the booklet is intended primarily to aid engineers in designing aluminum into process plants or equipment. Two-color graphs tell at a glance the yearly corrosion rate of more than 100 chemicals on aluminum. Copies of the brochure are available from Reynolds Metals Co., 2500 S. Third St., Louisville, Ky.

◆ ◆ ◆

More than 100 different applications for silicones are discussed in an illustrated catalog produced by

(Continued on page 62)

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(Continued from page 60)

the Silicone Products Dept., General Electric Co., Waterford, N. Y. Designated CDS-97, the eight-page catalog lists specialized literature covering product and application information, as well as major G-E silicone products.

◆ ◆ ◆

Meters, regulators and valves are the subject of a new catalog from Rockwell Manufacturing Co. The revised, condensed, 28-page booklet has been completely restyled, with emphasis on the use of photographs to illustrate all major products. Copies can be obtained from the Meter & Valve Division, Rockwell Manufacturing Co., 400 N. Lexington Ave., Pittsburgh 8.

◆ ◆ ◆

Multi-louvre dryers and how they work are described in Book 2609, published by Link-Belt Co. The 16-page book contains information on drying, cooling and processing of bulk materials and shows how the dryer is used in the food, chemical, processing and fertilizer industries for accurate temperature control. Typical layouts, dimensional data and a two-page psychometric chart are included, as well as step-by-step descriptions of how the Multi-Louvre dryer works. Book 2609 is available from the Link-Belt Co., Prudential Plaza, Chicago 1.

◆ ◆ ◆

Stainless steel mixing and storage tanks are featured in Bulletins 941 and 918, newly published by the Pfaudler Co., 1031 West Ave., Rochester, N. Y. The bulletins give complete construction and operating details for a full line of tanks designed for a variety of process applications.

◆ ◆ ◆

"Exciting News," a booklet published by Corn Products Sales Co., details the advantages of using a new corn adjunct concentrate to replace dry cereal adjuncts in the brewing of beer. The booklet also outlines a half-dozen suggested methods of using the new product in breweries where either total or partial adjunct replacement is desired. Tables compare the properties of the new product, Nu-Bru corn adjunct concentrate, with older types of syrups. Copies of the booklet can be obtained by writing Corn Products Sales Co., 17 Battery Pl., New York 4.

◆ ◆ ◆

Minneapolis-Honeywell Regulator Co. offers two new publications: Specification S705-1 describes the Brown non-indicating pneumatic pressure transmitter, for vacuum or pressure measurement; and Catalog C600/700-1 has data on Brown small-case indicating pneumatic controllers, also for either temperature or pressure. Copies of the publications can be obtained from the company, at Wayne and Windrim Aves., Philadelphia 44.

◆ ◆ ◆

A four-page bulletin, published by Fuller Co., Catasauqua, Pa., describes a new highway trailer designed for bulk transportation of sugar and other granular materials. Illustrated with photographs and drawings, the bulletin shows how the trailer is loaded and unloaded by means of air delivery. Copies of Bulletin A-19 can be obtained from the company.

◆ ◆ ◆

A 16-page catalog of laboratory analytical instruments has been published by Perkin-Elmer Corp., Norwalk, Conn. The catalog describes the company's line of infrared and ultraviolet spectrophotometers, monochromators, and flame photometers, as well as accessories and instrument components available for use with them.

◆ ◆ ◆

The latest wholesale price list of Fritzsche Bros., Inc.—covering flavors, colors, essential oils, and many other products—has recently been issued. Copies are available, to those whose purchases are in wholesale quantities, from the company, at 76 Ninth Ave., New York 11.

◆ ◆ ◆

The latest information on thermometers and hydrometers is in a new, 24-page booklet on the subject, according to the publisher, Central Scientific Co. The booklet contains a complete listing of ASTM and general and specific purpose thermometers and hydrometers for industrial and educational uses. Complete specifications, as well as prices, are given, and there are also general facts about proper use of the instruments. Copies of the booklet, Bulletin 40, can be obtained by writing the company, at 1700 Irving Park Rd., Chicago 13.

◆ ◆ ◆

New chromatographic equipment is featured along with a complete line of modern sectional laboratory furnishings in the latest issue of "Lab-Oratory," produced by Schaar & Co., 754 W. Lexington St., Chicago 7.

◆ ◆ ◆

An eight-page introduction to high-speed analog computers has been produced by GPS Instrument Co., 811 Boylston St., Boston 16. The booklet, "High-Speed Analog Computers, Key to Rapid System Development," answers questions from engineers, executives and educators who are concerned with automation and the development of control systems for industrial and military applications.

◆ ◆ ◆

Impervious-graphite cascade coolers, used to cool large volumes of corrosives, are illustrated and explained in a catalog published by Falls Industries, Inc., Aurora Rd., Solon, Ohio. Included are diagrams, photographs and "exploded" drawings, as well as pressure-drop calculations for each model.

◆ ◆ ◆

Characteristics and potential uses for Paraflint, a new synthetic paraffin, are described in a four-page brochure issued by Moore & Munger, 33 Rector St., New York 6. Paraflint, an exceptionally hard, high-melting-point wax, is a product of a new plant erected by the South African government to produce petroleum products from low-grade coal by the Fischer-Tropsch process.

(Continued on page 64)

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(Continued from page 62)

meeting hall and conference room . . .

Flavoring Extract Manufacturers Association, for its 48th annual convention May 19-22 in New York, has slated a wide-ranging technical program to review current activities and forecast future trends in the flavors field. Among topics on the advance program were talks on certified colors, the current vanilla bean market, and the vanilla research project of FEMA, being conducted by Boyce Thompson Institute; and reports of the FEMA's scientific research committee and food additive committee. A full social program was planned to supplement the technical sessions.

Following the close of the FEMA convention May 22, the Society of Flavor Chemists plans a luncheon and flavor symposium. Speakers will discuss such topics as "Origin of Flavor," and "Biosynthesis of Essential Oils," and a panel of flavor experts will be available for consultation. Information and luncheon tickets can be obtained from Fred Schumm, Ungerer & Co., Totowa, N. J.

◆ ◆ ◆

A three-day international symposium on gas chromatography has been scheduled for August 28-30. The symposium, sponsored by the Analysis Instrumentation Committee of the Instrument Society of America, will be held at East Lansing, Mich., and will provide an opportunity to discuss theoretical and practical advances in gas chromatography as applied to both laboratory analysis and industrial process control. Contributed papers relating to specific advances in the field are now being solicited by the program chairman, Vincent J. Coates, Perkin-Elmer Corp., Norwalk, Conn. Information about the symposium, and the required pre-registration forms, can be obtained from Henry J. Noebels, general chairman, IGC Symposium, Instrument Society of America, 313 Sixth Ave., Pittsburgh, Pa.

◆ ◆ ◆

Flavoring Extract Manufacturers' Association has scheduled its 48th annual convention for May 19-22 in New York City. Robert Krone, of Fritzsche Bros., Inc., and an IFT member, is chairman of the convention committee, which is planning varied social events to accompany the technical program. Included on the social calendar will be a hospitality party, a golf tournament, the president's reception preceding a dinner-dance, and the annual Chemists' Breakfast.

building up and branching out . . .

A recent survey reports that approximately 4,800 projects, 660 organizations conducting or supporting research, and about 5,000 professional research workers are engaged in food and nutrition research in the United States.

Nineteen hundred and twenty of the research projects pertain to nutrient metabolism and requirements, 1,440 to food chemistry and composition, 960 to food technology, and 480 to microbiology, food acceptance and nutrition education.

◆ ◆ ◆

Proctor & Schwartz, Inc., machinery manufacturer of Philadelphia, has announced plans to expand its facilities by establishing an additional plant in Waynesville, N. C. The new operation will begin on a small scale, employing local people and manufacturing textile fiber processing machinery. Later it will be expanded into sheet metal work and the manufacture of drying equipment. Proctor & Schwartz emphasized that it does not plan to leave Philadelphia; the Waynesville location was chosen to place the company closer to its markets in the textile and tobacco industries.

◆ ◆ ◆

The Kroger Co. has announced the latest addition to its manufacturing operations: a million-dollar, instant-coffee processing plan in Cincinnati, to serve nearly 1,500 retail stores in 21 states. The new plant, incorporating many improvements developed by Kroger, is said to have a capacity equalling more than 2,000,000 cups of coffee per day.

◆ ◆ ◆

THE AVI PUBLISHING COMPANY, INC., since 1921 publishers of the *Fruit Products Journal* and technical books for the Food Industry, was recently reorganized and its location changed from New York City to Westport, Conn. The company will continue the publication of books on food preservation and food technology under the management of Gerald A. Fitzgerald, Vice President and Secretary.

The first of the new books to be brought out will be the completely rewritten, greatly enlarged third edi-

(Continued on page 66)

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FOOD TECHNOLOGISTS

60 years of specialized experience in the manufacture of powdered vanilla products

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☐ Information for making dietetic _____
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Firm _____
Position _____
Address _____
City _____ Zone _____ State _____

(Continued from page 64)

tion of THE FREEZING PRESERVATION OF FOODS in two volumes: Vol. I—The Freezing of Fresh Foods, and Vol. II—The Freezing of Precooked and Prepared Foods, both under the authorship of Dr. Donald K. Tressler and Mr. Clifford F. Evers, authors of the two previous editions. Volume I is now off the press; the second volume will be ready in late spring or summer of 1957. THE FREEZING PRESERVATION OF FOODS is designed for the needs of the many professional fields and the application areas associated with food technology and science. As a reference book for all branches of the freezing industry it will be a constant source of consultation. Address Avi Publishing Company, Inc., Westport, Connecticut.

the human element . . .

Dr. T. A. White, technical director of the food division of National Starch Products, Inc., and an IFT member, recently received the U. S. Navy's Certificate of Commendation for his work as a member of the Food Service Advisory Committee of the National Security Industrial Assn. Rear Adm. R. J. Arnold, chief of the Navy's Bureau of Supplies & Accounts, presented the award during ceremonies at the Naval Operating Base, Bermuda, on behalf of the Secretary of the Navy.

Eleanor M. Crozier has been appointed by National Biscuit Co., New York, to the newly-created post of manager of consumer information in the company's home economics division. For the past two years Miss Crozier was director of home economics for Minute Maid Corp., and previously she had been with United Fruit Co., *Good Housekeeping* magazine, and Hoffman-La Roche, Inc. In addition to membership in IFT, she is active in such groups as the American Home Economics Assn., and the American Dietetic Assn.

Eleanor M. Crozier

Leo Freud, 53, technical sales and service representative for Fries & Fries, New York, died Feb. 11 at his home in Beech Hurst, N. Y. He had been associated with the company and active in the food industry for more than 30 years.

William Innes Drynan, president and director of Canadian Canners, Ltd., is the new president of the Canadian Processors Assn., succeeding Robert Flood of Waterloo, Que. Mr. Drynan also is president and director of Canners' Machinery, Ltd., and a director of three other Canadian Canners subsidiaries.

William Innes Drynan

John N. DeBoice has joined the public relations division of A. E. Staley Manufacturing Co., Decatur, Ill. He formerly was community relations supervisor of the Caterpillar Tractor Co. plant in Decatur and had served as newsman and editor on three Illinois newspapers.

Charles F. Radley has retired from active duty as director of publicity and board member of Oakite Products, Inc. One of the company's original directors, Mr. Radley will continue with Oakite as a consultant on advertising, public relations, and general management policy. He joined the company in 1917 and for the past 30 years had been responsible for Oakite's entire industrial advertising program.

Dr. James B. Evans has been appointed chief of the division of bacteriology of the American Meat Institute Foundation, and **Dr. J. Walter Giffee** has joined the foundation staff as chief of the division of hide research. Dr. Giffee, an IFT member, formerly was assistant chief of the radiation preservation branch of the Quartermaster Food and Container Institute.

Midwest listeners to Martha Crane's WLS (Chicago) show for women recently heard John C. Swift, general sales manager of White Cap Co., explain the advantages of the company's new twist-off cap for glass-packed foods. Mr. Swift was a guest on Miss Crane's program just prior to the recent National Canners' show.

Paul L. Kohnstamm was elected president of H. Kohnstamm & Co., New York, at a recent meeting of the board of directors. He succeeded **Louis J. Woolf,**

(Continued on page 68)

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At Froedtert — producer of world famous Fro-Malt — the welcome mat is always out for food technologists who seek research help in adapting specific types of malt to meet specific food requirements. With a rapidly growing interest in the many possible uses of Fro-Malt, Froedtert has expanded its research staff to include additional food technologists of its own, and has established a Home Economics Division.

This development of laboratory and kitchen facilities for practical research in the food field complements Froedtert expansion in *technical* research and *malting control.* In the Froedtert pilot malting laboratory the most advanced equipment and methods maintain precise temperature and moisture control at all times. Every phase of the malting process is under alert surveillance to assure a consistently pure and uniform supply of any desired type of Fro-Malt.

Fro-Malt refined flours are prepared from pure Fro-Malt milled for low fiber content and controlled particle size. They provide palatable, readily digestible food values in a form suited to the demands of modern food technology. These flours are economically shipped, ideal for precise blending, easily handled, and can be stored without loss of nutritional values. Also available in pulverized, crushed, or whole-grain forms, Fro-Malt can be obtained in a wide range of flavors and colors.

Recognition of Fro-Malt as a valuable flavoring agent has been an important factor in its increased food and beverage applications. Flavors vary from bland through light malted and caramel to stronger flavors. "Naturally" wholesome and nourishing, Fro-Malt contains powerful anti-oxidants which keep foods fresh-tasting for longer periods. Unlike powdered malt syrups, Fro-Malt flours are nondeliquescent and maintain the ability to flow freely even under adverse humidity conditions.

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FRO MALT

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FROEDTERT *Malt Corporation*

Milwaukee 1, Wisconsin

Where research is unlocking the secrets of barley malt

(Continued from page 66)

who was named board chairman. **Robert H. Pulver,** formerly sales manager of the company's midwestern division and a board member, was elected to the newly-created post of executive vice-president. Other changes in the 107-year-old firm included election of **Arthur D. Vogel** as vice-president and board member and the naming of **Walter J. Kohnstamm** as corporation treasurer.

Benedict F. Zimmer, Jr., has joined Fries & Fries, Inc., as technical adviser, after 16 years with Fritzsche Bros., Inc. Mr. Zimmer will make his headquarters at the company's New York office.

Benedict F. Zimmer, Jr.

Philip Berry, purchasing agent for Ungerer & Co., New York, returned recently from a three-week Florida trip during which he visited operators in the citrus oil industry.

Vernon K. Watson has joined the Long Island City headquarters of Food Research Laboratories, Inc., as senior food technologist. Mr. Watson, an IFT member, formerly was food technologist and plant superintendent with United Fruit Co., and he also served with Beech-Nut Packing Co. and with the department of agricultural chemistry at Washington State College.

W. Doss Lumpkin has joined the catalyst department of The Girdler Co., Louisville, Ky. He will specialize in the marketing of catalysts used in processing fats and oils. He formerly was with Phillips Petroleum Co. and Filtrol Corp. before joining Girdler in 1954.

Dr. B. E. Proctor (right), former national president of IFT, was among the guests at the American Can Company's second annual "College Day" program, March 13 at the Barrington, Ill. research laboratories. Canco scientist A. C. Wilbur (M.S., Stanford) also is shown here, at left. Forty-one scientists from departments of food technology, chemistry, and engineering at 26 different colleges and universities attended the all-day conference and toured the new multi-million dollar Canco Research Center. Dr. Proctor represented the Massachusetts Institute of Technology, where he is head of the Department of Food Technology.

Audrey Cheek has joined the staff of American Bio-Chemical Laboratory, Baltimore. Miss Cheek, a University of North Carolina graduate, has had technical experience in pesticide development and also in paper converting, with particular emphasis on plastic and wax treatments.

Dr. Arthur N. Prater, prominent IFT member, has been elected vice president of Consolidated Foods Corporation, Chicago, leading canner, processor and distributor of foods, according to an announcement by S. M. Kennedy, president. Well known throughout the food industry as a food technologist and administrator, Dr. Prater will continue as president of the

corporation's Gentry Division, Los Angeles, California, processor of dehydrated foods and seasonings, an office he has held since September, 1956. He has been associated with Gentry for the past twelve years. Dr. Prater was formerly president of Research & Development Associates, Food and Container Institute, and chairman of the American Chemical Society, Division of Agricultural and Food Chemistry.

Ocoma Foods Co., Omaha, has relocated two of its sales department at 232 Broad Ave., Palisades Park, N. J. **William Lyons,** division sales manager for Ocoma's frozen retail pack, and **Anthony Del Balso,** military sales manager, will operate from the new location.

Edward F. Burke has been named division manager of the Flexible Packaging Div. of Standard Packaging Corp. He formely was product sales manager for the division. In his new post, he will supervise all operations at Standard's Clifton, N. J., plant.

John N. Hinckley is the new works manager for the Manton-Gaulin Manufacturing Co., Everett, Mass. He will be responsible for engineering, development, production and quality control of all the company's products.

Al Bobrow, formerly with Foremost Dairy Processors, has been appointed a representative of American Food Laboratories, Inc. He has been assigned to the New England states.

James L. Vaughan has been appointed assistant research director of the Dewey & Almy Chemical Co.

division of W. R. Grace & Co., Cambridge, Mass. He will be in charge of process design and development. Formerly he was director of process engineering with the National Research Corp.

John T. Goodwin, Jr., is the newly-appointed technical director of Corn Industries Research Foundation, Inc. He will administer research and development programs sponsored collectively by companies in the corn refining industry. **Norman F. Kennedy,** former research director, will serve as consultant to Dr. Goodwin until his retirement in the near future. Dr. Goodwin, an IFT member, formerly was manager of the chemistry division of Midwest Research Institute, Kansas City, Mo. In his current post, he will be at the new research offices of CIRF at 1001 Connecticut Ave., N. W., Washington, D. C.

John T. Goodwin, Jr.

Dr. Clell B. Hartley is the new research laboratory manager for Fairmont Foods Co., Omaha. He joined Fairmont after five years with Kraft Foods Co.

Adolph Dingfelder, sales manager of Felton Chemical Co., Brooklyn, N. Y., was due to return this month from a six-weeks trip to Europe. His itinerary included visits at the company's manufacturing branch in Versailles and with sales representatives in five countries.

Fred Whiteside Corp., Boston, has been appointed by Proctor & Schwartz, Inc., Philadelphia, as manufacturer's agent in New England and the South.

IFT member Robert G. Fries, Jr. (right), vice-president of Fries & Fries, Inc., Cincinnati, has found helicopter service a time-saver in traveling between the Cincinnati airport and his factory, 20 miles away. He is shown here on arrival after a recent trip from the east.

J. C. Findlan has been promoted to sales manager of the Geigy Industrial Chemical Div. of Geigy Chemical Corp., Ardsley, N. Y. He had been a field representative for the company since 1953.

Millmaster Chemical Corp., New York, has been named sales representative for glycerine produced by Lever Brothers Co.

Dr. Ernest Guenther, vice-president and technical director of Fritzsche Bros., Inc., New York, was scheduled last month to appear before three groups of Canadian food technologists. Dr. Guenther planned to report on his personal survey of production of essential oils in Europe and North Africa. He recently returned from an inspection tour of the essential oil industry in West Indian and Caribbean areas.

Evans Research & Development Corp., expanding its activities, has added four staff members. **Harold E. Worthman** has been named research chemist, and new junior chemists are Elinor M. Cohen, **Frances E. Goldenson,** and Charles John Coreschi.

Dr. F. Neville Woodward has been named to direct operations of the new Arthur D. Little Research Institute at Inveresk, Scotland. Under Dr. Woodward's leadership, the institute, sponsored by Arthur D. Little, Inc., Cambridge, Mass., will carry on fundamental scientific investigations.

In a series of awards announced by Diamond Crystal Salt Co., St. Clair, Mich., **Horace C. Hutto,** Minneapolis district manager, received his 35-year diamond service pin; and **William G. Probst** and **William J. O'Connell,** New York and Cincinnati district managers, respectively, were named to share the honor of "District Manager of the Year."

Herbert Parker, sales engineer in the Atlanta district office of Rockwell Mfg. Company's Meter & Valve Division, has been promoted to Atlanta district manager.

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University of California
Dept. of Food Tech.
Davis, Calif.

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Burnett Meat Company
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Dr. C. O. Willits
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Philadelphia 18, Pa.

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U. S. Yards
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Decatur, Ill.

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Los Angeles 38, Calif.

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Springfield, Ore.

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Parkview Apt. No. 39, Broad St.
Athens, Georgia

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New Brunswick, N. J.

James K. Moore
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Racine, Wis.

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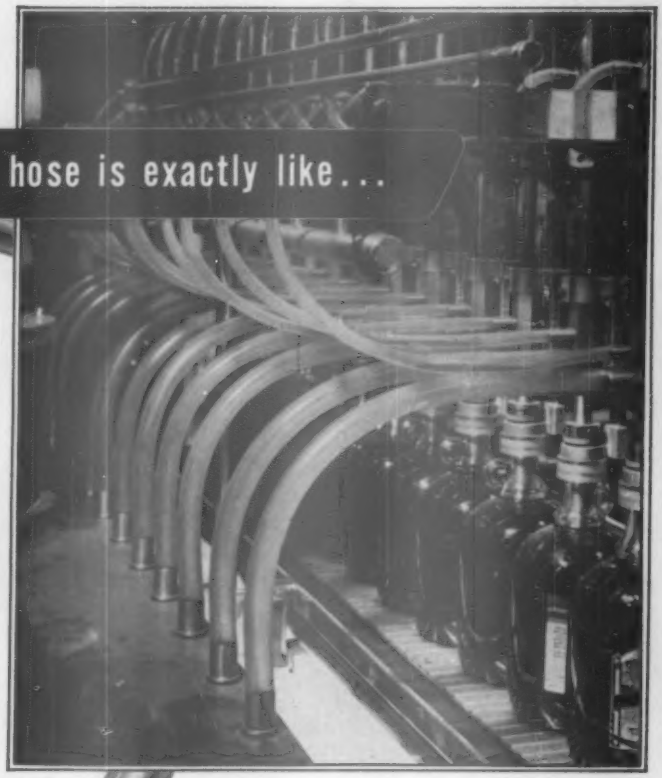

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